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ABSTRACT

The curriculum guide is designed to help high school administrators, teachers, and others to develop or expand a program to introduce all students to general computer capabilities, to provide certain students with a problem solving tool, or to prepare other students for entry into the job market. Help is given in planning and organizing the program, curriculum outlines for the four high school years are included, and the courses are described briefly. Fourteen instructional units cover advanced COBOL programing, beginning keypunch, business applications development, computer operations, FORTRAN applications programing, introduction to COBOL programing, introduction to computers, introduction to programing, keypunch and data entry, office machines, procedures for organizing information, programing projects, punched card data processing I, and punched card data processing II. A section outlines what library support is necessary for the curriculum. A chapter on facilities, equipment, and costs involves such things as transporting students to computer facilities, terminals only, building requirements, acoustics, air conditioning, safety precautions, and others. (MS)

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COMPUTERS AND CAREERS

A SUGGESTED CURRICULUM FOR GRADES 9-12

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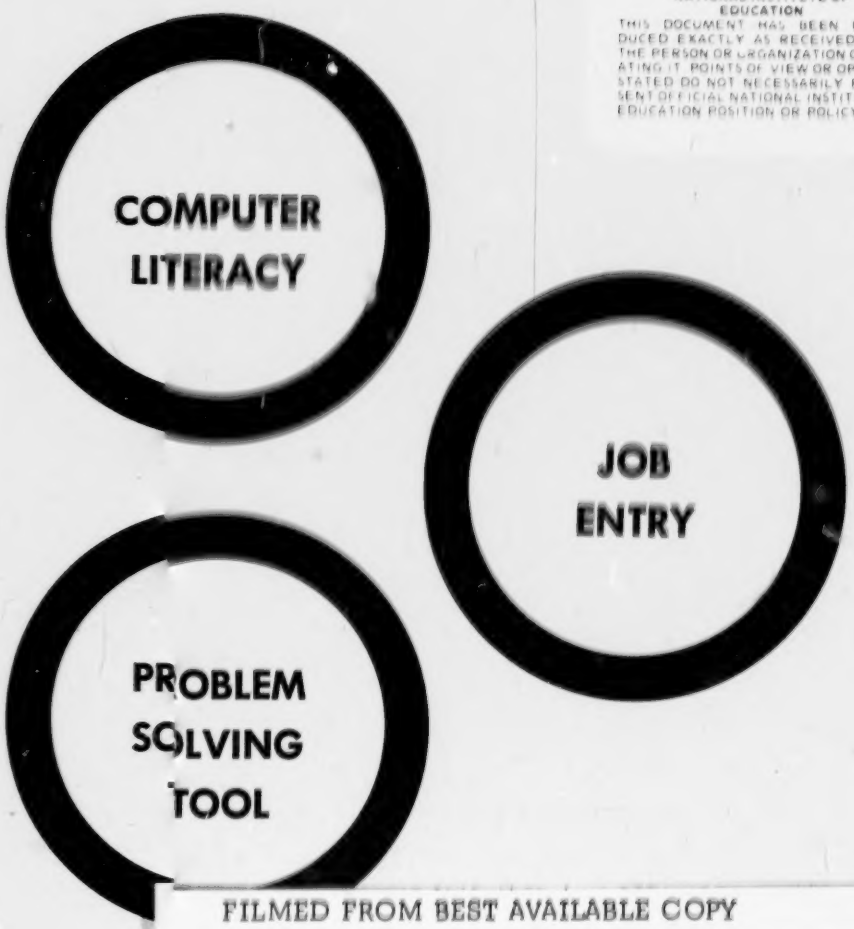

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COMPUTERS AND CAREERS

A Suggested Curriculum for Grades 9-12

Central Texas College
Killeen, Texas

Developed pursuant to a grant
with the
U.S. Office of Education
by
Central Texas College
Killeen, Texas
1973

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FOREWORD

Parallel with the rapid development of computer and data processing technology, high school principals across the nation are experiencing a growing demand for educational programs in this comparatively new field. Year by year, since the mid-1960's, the number of high schools that have undertaken such programs has increased steadily. Concurrently, existing programs have been expanded both in terms of student enrollment and in the scope of curriculum content. These programs deal generally with three learning objectives: to achieve literacy in computer fundamentals, to learn to use the computer as an aid in further studies, and to achieve technical competence in preparation for job entry.

Many high school administrators, however, hesitate to undertake the development of data processing programs because of their unfamiliarity with the program area. Their need is for guidelines to assist in developing quality data processing programs where requirements for such programs can be identified clearly. To provide these guidelines is the purpose of this publication.

This suggested guide identifies and describes special problems in defining, initiating, and operating effective programs. Recommendations are provided on the following topics as they relate particularly to program development: classroom requirements, laboratory and library facilities, the library collection, the faculty, student selection and services, and the curriculum. The material presented reflects the accumulated experience of successful programs and the consensus of many technician educators, employers, school administrators, teacher educators, consultants, and other persons who have distinguished themselves in the field of technician education and who have made substantial contribution to this publication.

This publication will assist Federal, regional, State, and local educators and their advisory committees in initiating new high quality computer related education programs or in improving existing programs. It will also assist teacher educators, program evaluators, employers of technicians, guidance counselors, and others interested in technical education. It is a suggested guide to be used or modified as necessary to suit the needs of a particular local situation.

This guide was developed under the direction of Alton W. Ashworth, Jr. and Suzette Gebolys, Central Texas College, with the assistance of William Berndt and Walter J. Brooking, members of the Bureau of Adult, Vocational, and Technical Education, Office of Education, Department of Health, Education, and Welfare.

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CONTENTS

	Page
FOREWORD	iii
ACKNOWLEDGMENTS	v
INTRODUCTION	1
Purpose of the Curriculum Guide	1
Program Objectives	1
PLANNING AND ORGANIZING THE PROGRAM	3
Development of the Program	3
Advisory Committees	3
Organizational Patterns	4
Occupational Information and Employment Opportunities	5
Student Populations and Services	6
Staff Qualifications	6
Laboratory Equipment and Facilities	7
THE CURRICULUM	9
Curriculum Outline	9
Brief Description of Courses	11
Curriculum Content and Relationships	12
Cooperative Vocational Education Programs	13
INSTRUCTIONAL UNITS	15
Advanced COBOL Programming	15
Beginning Keypunch	18
Business Applications Development	21
Computer Operations	23
FORTRAN Applications Programming	24
Introduction to COBOL Programming	25
Introduction to Computers	28
Introduction to Programming	29
Keypunch and Data Entry	31
Office Machines	33
Procedures for Organizing Information	35
Programming Projects	37
Punched Card Data Processing I	38
Punched Card Data Processing II	40
LIBRARY SUPPORT FOR THE SUGGESTED CURRICULUM	41
Library Staff and Budget	41
Suggested Technical References	41

Page

LABORATORY FACILITIES, EQUIPMENT, AND COSTS 43

Transporting Students to Computer Facilities 43
Terminals Only 43
On-Campus Computer Facilities 44
Equipment Costs 44

BIBLIOGRAPHY 52

APPENDIXES 53

A. List of Resource High Schools and Public School Systems . . . 53
B. Curriculum Adapted to a 1-Year Program 54
C. A Selected List of Film Distributors 56
D. Supplementary References for Use in Secondary School Instruction 58

INTRODUCTION

That computers have affected the lives of nearly all of us is indisputable. Their impact has been experienced in areas as widely separated as space research and preschool instruction. This impact is even more remarkable when the computer's brief history is recalled. In 1950, there were fewer than 15 electronic digital computers in worldwide use. By the late 1960's, over 40,000 were in operation and the number is expected to exceed 100,000 during the 1970's.

Computer applications have penetrated, directly or indirectly, nearly every aspect of human affairs. Computers are used to design ships, to aid in their construction, and to operate and navigate the completed vessels. Computers made possible the design and construction of spacecraft, their launching, control, and navigation to the moon. Computers also have been applied to less exotic but none the less significant roles in the functions of government, law enforcement, education, business, commerce, and the sciences. Computerized social security and income tax deductions touch the lives of nearly all citizens. The seemingly unlimited usefulness of the computer itself has been augmented by the rapidly accelerating development of peripheral equipment and data communications systems. This development has brought into use extensive networks in which a single computer, located in one city, provides service to terminals in other cities across the nation.

The phenomenal development of computer technology has created an increasing demand for competent data processing personnel. Consequently, individuals who are knowledgeable about computer capabilities are enjoying increased career opportunity and flexibility. The concept of "careers related to computers" is fast becoming an important educational consideration as schools come to recognize their responsibility to prepare students to work in a computerized society.

Purpose of the Curriculum Guide

This guide has been prepared as an aid for high school administrators, teachers, and others concerned with the development or expansion of a program to introduce all students to general computer capabilities, to provide certain students with a problem-solving tool, or to prepare other students specifically for entry into the job market upon graduation.

Program Objectives

The materials presented in this guide are representative of programs that have been implemented successfully by high schools of varied characteristics and with similar, but not duplicative, objectives (appendix A). These programs are termed "successful" because they achieved a planned purpose or made significant progress to that end. Each high school staff received the active assistance of an advisory committee drawn from the community. Together, they defined student and area needs for a computer education program in their local high school; together, they initiated the program and moved it toward its stated objectives.

These objectives include:

- Within the scope of the high school curriculum, all students will be given an opportunity to achieve computer literacy, and thereby understand the computer's role in their daily lives.
- Provide a problem-solving capability to students interested in using the computer as a learning tool in their post high school experiences.
- Prepare qualified students for job entry in the data processing field. Programs in this category should be undertaken only when there is clear evidence of a data processing job market where graduates can expect placement.

The programs by which these objectives are achieved are illustrated in figure 1.

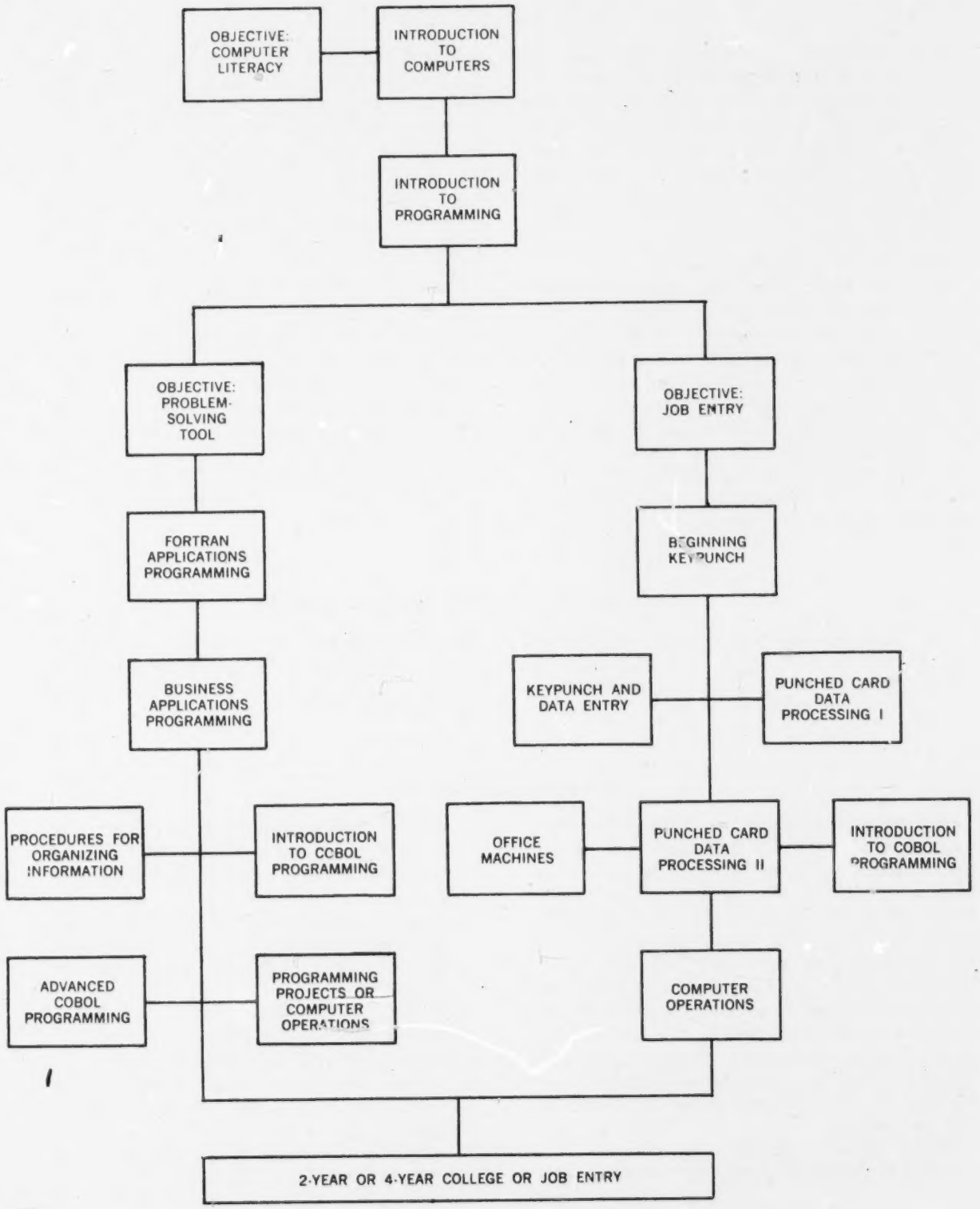


Figure 1. — Program objectives and organization

PLANNING AND ORGANIZING THE PROGRAM

Regardless of the variations of locale and environment in which a computer education program can be undertaken, there are certain basic considerations that require attention. Since these matters relate to program feasibility, they should be dealt with in the preliminary study phase of development planning.

Development of the Program

A school superintendent has many factors to evaluate in considering whether to initiate a new high school course or program. The administrator may become aware of a new course or curriculum need from various sources. Student or parent interest, school staff initiative, recommendations from personnel with State or local boards of education, area employers, offerings of other school systems, and national meetings or publications are all potential sources for new curricular approaches.

Consideration of the program should begin with a comprehensive State, regional, and local school district area study. This study can be conducted with the assistance of people familiar with the areas in which data processing technology is in use or anticipated. Such a study determines educational needs, identifies community support, evaluates student population and interest, and forms a basis for deciding whether or not to offer the program.

The following questions should be answered affirmatively before any phase of the curriculum is adopted for use in district schools:

1. Is projected student population and interest sufficient to justify the program?
2. Does the program meet a need of the State or community at reasonable cost?
3. Does the local board of education understand the educational objectives of the program? Will the board support the program with personnel, funds, and cooperation?
4. Will financial support be adequate to provide the program with buildings, facilities, and faculty, and to maintain it by providing the proper educational aids and equipment essential to the conduct of a high quality program?
5. Is the program responsive to student needs and interests, and will it enjoy the support of the administration and staff of the high school where it will be offered?
6. To staff the computer and data processing courses, does the existing faculty include qualified personnel, can such personnel be obtained, or can existing faculty members be professionally upgraded?
7. Will provisions be made for effective student guidance services prior to the student entering the program and during participation in the program, and for an enlightened placement service upon graduation?

In attempting to answer such questions, a superintendent not only should seek the recommendations of qualified staff personnel but enlist the services of an advisory committee to assist in the decision-making process.

Advisory Committees

The advisory committee[1] for the computer science data processing program should consist of area employers, representatives of scientific and technical societies in the field, computer operating personnel, knowledgeable civic leaders, and representatives of area community and junior colleges, 4-year colleges, and universities in which high school graduates might enroll. Such members serve without pay as interested citizens; they enjoy no legal status, but provide invaluable assistance to the school board and its staff. The committee normally consists of about 10 members (but may range from 6 to 12), who generally serve for a 1- to 2-year period. The school superintendent or the curricular assistant ordinarily is chairman.

The committee assists in surveying and defining the need for technicians; the knowledge and skills they will require; employment opportunities; available student population; curriculum, faculty, laboratory facilities and equipment; the extent of community support, and cost and financing of the program. When the studies indicate that a program should be initiated, the committee's help in planning and implementing it is vital.

Frequently, the committee helps school district administrators obtain local funds, and State and

[1]American Vocational Association. *The Advisory Committee and Vocational Education.* Washington: The Association, 1969.

Federal support for the program. The committee can also help assure careful articulation of the high school's program with those offered at area institutions of higher education where its graduates are likely to enroll for additional education and training. In addition, when the graduates seek employment, the committee can aid both in placing them in jobs and in evaluating their work performance. Such evaluations often will result in minor modifications which will more closely relate the program to employment or college requirements.

Organizational Patterns

Since this program is designed to help all high school students achieve basic computer literacy, provide some students with a problem-solving tool, or prepare other students to enter the job market, there are many organizational patterns available to the administrator who would manage these diverse objectives efficiently. The following discussion outlines some of the viable patterns.

Computer Literacy Objective

One of the primary goals of the curriculum outlined in this guide is to provide an opportunity to all high school students to become aware of computer capabilities and uses. It is recommended that this computer literacy program be introduced in the ninth grade. Ideally, *Introduction to Computers* should be a required course replacing an elective in the second semester of the ninth grade. It is not, however, a prerequisite for other courses. *Introduction to Programming* serves to expand the literacy experience in the tenth grade by providing students with computer language and flowcharting capabilities; where this is done, students who wish to do so can make use of the computer during their high school experience. They also gain insights which enable them to give early consideration to data processing as a career area that affords specific occupational opportunities.

The two-course computer literacy sequence does not require any equipment to achieve its educational objectives. While the presence of computer hardware would be an asset to the instruction, equipment need not be procured to support these two courses.

In attempting to implement a program designed to acquaint all high school students with computer science and data processing, the school administration must consider certain important variables. First, whenever a program is offered to all students, a vast spectrum of student differences must be anticipated. It is not sufficient to simply acknowledge that such differences in abilities and interests exist while continuing to plan an inflexible program for the "typical" freshman. In a larger school, student characteristics can be accommodated partially by altering the orientation of various sections of the same course. Using this method, *Introduction to Computers* could have several sections from which the student can select group discussion, independent study, or lecture-discussion techniques of instruction. A second variable to be considered when introducing a computer literacy program is the desirability of relating such a program to both the students' other courses and to the information and guidance they are receiving about various career possibilities. For an introduction to computer applications to have maximum impact on high school students, it must be related intimately to what they are currently learning in other areas, and to what they may eventually be involved with as working adults and citizens. If these relationships are clearly evident, student enthusiasm and motivation for the program will be substantially enhanced.

For a computer literacy program to be optimally effective, it must occur early in the students' academic preparation, be correlated closely to their other learning and supportive experiences, contribute to their perceptions of career possibilities, and accommodate as much as possible their individual needs and expectations.

Problem-Solving Objective

In addition to acquainting all high school students with general computer capabilities, this curriculum has the potential for providing certain high school students with problem-solving capabilities. A student who anticipates a career in engineering, for instance, might elect several data processing courses to augment a science major and serve as a background tool for further study. Any high school which adopts this curriculum should be administratively prepared to respond to such student requirements.

The courses offered at the eleventh and twelfth grade levels equip students to use the computer

as a problem-solving tool or to seek employment in the field of data processing. Courses to meet both objectives can be administratively organized in a variety of ways, including:

- As a segment offered within an existing department, such as mathematics or business.
- As a separate data processing department at the local high school.
- As a department at a central or area technical high school.

Each arrangement has advantages and liabilities which must be evaluated by local administrators. It is recommended, however, that if many of the courses suggested in this guide are offered by a local high school, a separate department be created to administer them. This arrangement encourages greater coordination and continuity among the separate courses, and stimulates a professional career conscicusness among faculty and students.

Job Entry Objective

Courses designed to prepare high school students for job entry in the data processing field can be offered in a separate data processing department at local high schools or area technical schools. Usually, data processing majors enroll for such courses in the eleventh and twelfth grades while concurrently completing other course requirements. An alternate administrative arrangement for offering data processing courses to high school students who are preparing for job entry is to present the total program in the senior year. This arrangement (detailed in appendix B) means basically that the students attend data processing classes for three hours each day, either in the morning or the afternoon; during the remaining portion of the day, students are scheduled for their other subjects. The major advantage of this arrangement is its possibilities for integration and continuity of learning experiences. Techniques and theories are not fragmented or divided into separate courses, but rather can be related into logical curricular sequences independent of time restraints.

Regardless of the organizational pattern selected to administer the job entry program in data processing, these courses should not be initiated unless there is substantial evidence that they will be required for a minimum of ten years. The expense of establishing a new program, including the cost of computer equipment, is unwarranted unless such a program would provide a necessary educational service for that length of time.

Occupational Information and Employment Opportunities

Although data processing is a relatively new employment area, it has achieved sufficient stability for tentative definition of specific job clusters. Since each cluster may require somewhat different abilities for a successful career, most graduates will continue to develop their skills through on-the-job or part-time study. The following list indicates some of the major clusters of job opportunities available to graduates of a successful high school data processing education program:

- Tab operator: operates an alphabetic and numeric keypunch machine, similar in operation to an electric typewriter, to transcribe data from source material to data cards.
- Electronic data processing peripheral equipment operator: operates dictaphone, adding machine, calculator, and other office equipment in addition to the keypunch machine; performs general office duties requiring the use of bookkeeping, business writing, and arithmetic.
- Coder/Programmer: flow charts program specifications, prepared usually by a systems analyst; codes the flow-charted data into a program language; uses selected data to test and correct the completed computer program.
- Terminal operator: operates terminal and off-line equipment to communicate between user and remotely located computer facility.

Many studies have attempted to assess the number of trained personnel needed to maximally use computers now existing and those projected to be in service by 1975, 1980, even 1985. While there is considerable disparity in the results of these studies, all consistently estimate that a shortage of trained data processing personnel exists now and is expected to continue indefinitely. Programmers and operators of peripheral data processing equipment are included in this shortage. In the data processing field, as in all areas of endeavor, there is a particular demand for personnel with a substantial background of training

and a record of academic or on-the-job competency. Employers cannot afford inadequately trained employees in data processing operations where the opportunity for error is great and the cost of error sometimes disastrously high.

Student Populations and Services

Because of the diversity of educational objectives found in a high school computer science program, a wide variety of student capabilities and interests will be represented in any such program. At the computer literacy level it will be necessary to intellectually communicate with many types of students. On the other hand, a homogeneity of student abilities usually will be desirable in the more advanced courses. The high school computer science program is not concerned exclusively with the production of skilled technicians; it also recognizes an educational commitment to broaden student awareness of computers and to equip certain students with the background necessary to challenge more sophisticated material. Therefore, it is essential that the coordinators of the program remain cognizant of their manifold responsibilities.

Beyond achieving basic student literacy with the computer and its use, it is essential that students accepted into the broader data processing program have certain capabilities. If the incoming student's background is inadequate, the instructors may tend to compromise the course work to allow for the inadequacies, with the probable result that the program will be inferior in depth and scope.

The students who will select and be qualified for the job entry program in data processing should have similar backgrounds and capabilities and should exhibit some evidence of maturity and seriousness of purpose. Wide ranges of ability among students can create an inefficient teaching situation and thereby prevent the program from progressing at the necessary rate. The amount of material to be presented and the principles to be mastered require students who not only are well-prepared in formal course material but also have the personal motivation to master a difficult program and to develop their capabilities to the limit.

In any type of academic preparation, effective guidance and counseling are essential to the data processing student. Wherever possible, students should be aided in selecting educational and occupational objectives consistent with their interests and aptitudes. Students should be advised to review their educational objectives if it becomes apparent that they lack interest in the data processing program or lack ability to complete the program satisfactorily.

Graduates of the data processing program who seek jobs should be aided in finding suitable entry employment. Placement officers should be aware of the needs of the region's business and industrial computer centers and should acquaint prospective employers with the qualifications of graduates. The school should also conduct periodic followup studies of its graduates to determine their on-the-job progress and to evaluate the effectiveness of their training. Such studies can indicate how the program or teaching techniques can be improved to meet current employment requirements and how job placement for graduates can be facilitated.

For those students who choose further formal study in the field of data processing or computer science, updated files should be available on appropriate 2-year and baccalaureate degree programs. While course and credit transfer evaluation is always a function of the receiving institution, colleges will frequently extend credit-by-examination to high school students with well-developed backgrounds.

At all educational levels, a commitment should be made to determining and meeting both the immediate and long-term needs of the students enrolled in the data processing program. This commitment encompasses sound academic preparation and advisement, vocational and personal counseling, job placement, and information regarding advanced education.

Staff Qualifications

The success of any program necessarily is dependent upon the employment of well-qualified instructors, having a command of the subject matter involved and a working knowledge of all the manipulative skills and theory necessary for the presentation of the material.

Teaching personnel for a high school offering only the computer literacy sequence need not be as sophisticated in machine language or in computer operations as instructors concerned with the technical specialties. However, such teachers

must be well versed in computer potential, limitations and applications, and be able to relate the significance of computers to the work force, government, the arts, the professions, and especially to the life of the individual. Humanistic and interdisciplinary backgrounds are particularly desirable for the instructors of *Introduction to Computers.* Such personnel might be found on an existing staff and their potential expanded by participation in a summer seminar or an institute on computer literacy. Interdisciplinary team teaching is another means of optimizing the capabilities of existing staff without retaining additional personnel.

Instructors in technical specialties should have educational backgrounds of at least a 2-year technical program in addition to a minimum of 3 years of work experience in the field; this suggested background should be expanded by the individual State requirements for teacher certification and in-service experiences. A minimum of three full-time faculty members is required to teach the technical specialty courses in a typical data processing curriculum, bearing in mind that entering classes of 20 to 30 students can be taught in lectures but may have to be divided into two sections of 10 to 15 for laboratory work. One of the full-time instructors usually is recognized as the head of the program and can be expected to devote considerable time to program administration.

The high school must attempt to bring the most competent instructors into the classrooms. It should aim at employing faculty with both technical qualifications and substantial teaching ability. It may carefully consider seeking instructors "on loan" from computer centers and industrial firms, or employing specially qualified instructors part-time or as guest lecturers.

If the scope and depth of training given are to be adequate, programs in data processing must be a series of well-integrated courses. Careful consideration must be given to timing the introduction of a new concept. This may, perhaps, be accomplished through "team teaching" in which the data processing staff is organized into coordinated teaching units. Teaching assignments then are made on the basis of the individual member's special training and talents. Concurrent courses are coordinated by team members to best use the students' time while they are moved smoothly on to progressively higher levels of understanding.

Careful planning of laboratory experience is also important. Laboratory sections should not be overloaded with students, particularly when a project requires "hands-on" use of a computer or peripheral equipment. If too many students try to work at a single terminal, for example, most of them will not benefit because they cannot participate sufficiently in doing the work. An optimum group size usually is two, although some projects can be effective for groups of three or even four students. If too many projects are in progress, however, the instructor cannot be attentive to each and the work cannot be coordinated adequately with related theory lectures.

Laboratory Equipment and Facilities

Laboratory experience is a vital part of any computer science or data processing program and is considered absolutely essential to the achievement of the curriculum objectives. Equipment should be selected to comprehensively support the objectives of the laboratory experiences and should be representative of that currently being used by employers and educational institutions.

The computer literacy sequence can be offered without the use of computer hardware. While access to a computer facility might greatly augment student understanding and motivation, *Introduction to Computers* can readily be taught without such equipment. *Introduction to Programming* acquaints students with flow-charting and programming procedures; by physically transporting the data and/or users to and from the computer site, a high school can offer such a course without the costly acquisition of equipment. While long-term transporting of data or students would probably prove cumbersome, to do so for only one course is a viable option.

Equipment selection becomes a significant factor when a high school or district decides to offer courses to meet the problem-solving or job entry objectives. Selection should be based on how well the instructional environment simulates current computer applications and practices. The equipment used in a computer laboratory is expensive and tends toward obsolescence after a few years of use. To help minimize the financial burden,

many equipment manufacturers now offer a lease program with an educational discount. The question of lease or purchase is one which each school system will have to resolve. It will suffice here to point out that a danger exists in attempting to utilize a purchased system beyond the limits of practicality, whereas a leased system is more easily "modernized" when economic concern is paramount.

Consideration should be given to the possibility of using remote terminal units connected to a conveniently available central computer facility whenever such a facility is located in the area. This may well prove more economical than investing in a central processing unit to be installed in the institution itself. Furthermore, access to a machine much larger, more powerful, and possessing far greater capabilities than one likely to be found suitable for an educational institution, would provide opportunities for more comprehensive programming exercises.

Obviously, there are many system configurations which will meet the minimum requirements for a program such as described in the following course outlines. However, valuable insights can be gained by utilizing the professional advice and recommendations of an advisory committee of educators and local and national employers of programmers. It is of particular importance to formulate and implement plans for equipment procurement only with the active assistance of such a committee.

THE CURRICULUM

Curriculum Outline

Computer Programming (Objective: Problem-Solving Tool)

	Periods Per Week		
	Class	Lab	Total
Grade 9, First Semester			
English	5	0	5
Mathematics	5	0	5
Science	4	1	5
History	5	0	5
Elective*	—	—	5
Total			25
Grade 10, First Semester			
English	5	0	5
Mathematics	5	0	5
Science	4	1	5
Elective*	—	—	5
Elective*	—	—	5
Total			25
Grade 11, First Semester			
English	5	0	5
Mathematics	5	0	5
History	5	0	5
FORTRAN Applications Programming**	3	2	5
Elective*	—	—	5
Total			25
Grade 12, First Semester			
English	5	0	5
Civics	5	0	5
Procedures for Organizing Information**	5	0	5
Introduction to COBOL Programming**	3	2	5
Elective*	—	—	5
Total			25

	Periods Per Week		
	Class	Lab	Total
Grade 9, Second Semester			
English	5	0	5
Mathematics	5	0	5
Science	4	1	5
History	5	0	5
Introduction to Computers**	3	0	3
Total	22	1	23
Grade 10, Second Semester			
English	5	0	5
Mathematics	5	0	5
Science	4	1	5
Introduction to Programming**	3	2	5
Elective*	—	—	5
Total			25
Grade 11, Second Semester			
English	5	0	5
Mathematics	5	0	5
History	5	0	5
Business Applications Development**	2	3	5
Elective*	—	—	5
Total			25
Grade 12, Second Semester			
English	5	0	5
Economics	5	0	5
Advanced COBOL Programming**	3	2	5
Programming Projects (or Computer Operations**)**	1/3	4/2	5
Elective*	—	—	5
Total			25

*Suggested electives might include Language, Typewriting, Accounting, or other courses to meet the student's individual program objectives.

**Course description and outline are provided in following section.

EDP Peripheral Equipment Operation (Objective: Job Entry)

	Periods Per Week Class	Lab	Total
Grade 9, First Semester			
English	5	0	5
Mathematics	3	0	5
Science	4	1	5
History	5	0	5
Elective*	—	—	5
Total			25
Grade 10, First Semester			
English	5	0	5
Mathematics	5	0	5
Science	4	1	5
Typing	0	5	5
Elective*	—	—	5
Total			25
Grade 11, First Semester			
English	5	0	5
Mathematics	5	0	5
History	5	0	5
Accounting	5	0	5
Beginning Keypunch**	1	4	5
Total	21	4	25
Grade 12, First Semester			
English	5	0	5
Civics	5	0	5
Office Machines**	3	2	5
Punched Card Data Processing II**	3	2	5
Introduction to COBOL Programming**	3	2	5
Total	19	6	25

	Periods Per Week Class	Lab	Total
Grade 9, Second Semester			
English	5	0	5
Mathematics	5	0	5
Science	4	1	5
History	5	0	5
Introduction to Computers**	3	0	3
Total	22	1	23
Grade 10, Second Semester			
English	5	0	5
Mathematics	5	0	5
Science	4	1	5
Introduction to Programming**	3	2	5
Elective*	—	—	5
Total			25
Grade 11, Second Semester			
English	5	0	5
Mathematics***	5	0	5
History	5	0	5
Keypunch and Data Entry**	2	3	5
Punched Card Data Processing I**	3	2	5
Total	20	5	25
Grade 12, Second Semester			
English†	5	0	5
Economics	5	0	5
Computer Operations**	3	2	5
Elective‡	—	—	5
Elective‡	—	—	5
Total			25

*Suggested electives include Business Law, Shorthand, Psychology, Speech, Language, or other courses which meet the student's specifc program objectives.

**Course description and outline are provided in following section.

***Business Math is recommended.

†Business English is recommended.

‡This time could be dedicated to a co-operative education project.

Brief Description of Courses

The following course descriptions are categorized under Literacy, Computer Programming (Objective: Problem-Solving Tool), and Electronic Data Processing (EDP) Peripheral Equipment Operation (Objective: Job Entry). Literacy courses are common to the other two categories.

Course descriptions are listed in each category in the order in which they are presented in the curriculum.

LITERACY

Introduction to Computers

An introductory course covering the fundamentals of data processing vocabulary, basic descriptions of hardware and its uses, a history of hardware applications, and a survey of the functions of software. The student is oriented also to the implications of future computer technology and the interface between the computer and society.

Introduction to Programming

An introduction to BASIC computer language and flow charting, including the preparation and processing of individual programs; also, operating procedures for computer systems including practical concepts of operating systems and the functional role of CPU and peripheral components. The student receives "hands-on" experience with a computer system.

COMPUTER PROGRAMMING (OBJECTIVE: PROBLEM-SOLVING TOOL)

FORTRAN Applications Programming

Designed as a first course in FORTRAN Programming; stresses fundamental principles of developing simple alogrithms, flow-charting and coding programs in a modern higher level language. As a prerequisite, students should show reasonable proficiency in mathematics and should be capable of taking Algebra II concurrently with this course.

Business Applications Development

This course deals with the development of problem-solving procedures prior to their computerization and with the use of flow-charts to describe such procedures. Included are characteristic flow-chart components, procedure execution, loop structure, singly subscripted variables, creation and use of subprograms, and various applications. Examples are the use of FORTRAN as a vehicle for communicating problem solving procedures to the computer, consideration of documented case studies in which computers have been applied to business problems, and the use of computers in business organizations. Further applications to be studied include sequential processing systems, characteristics and applications of real-time systems, and the implementation and operation of computer systems. Students define problems, and design, code, and test several FORTRAN programs of increasing difficulty, both in batch and time-sharing mode.

Procedures for Organizing Information

A course in designing systems for business data processing. Subject areas include business systems and procedures, the kinds of information required by management, the equipment available for processing data, and the techniques necessary to bring all these elements together. The tools of systems work are discussed and analyzed, including various flow-charts, methods of acquiring data for analyzing office functions, decision tables, forms control, and identifying and describing employee task situations in the flow of paper work.

Introduction to COBOL Programming

This beginning course in business programming emphasizes business practices and the use of a business-oriented language, COBOL. Included is practice in the functions of the language instruction set, flow-charting, and non-scientific problem solving. File processing is limited to sequential files. The course is designed to give the student adequate business programming experience and the use of a programming language.

Advanced COBOL Programming

A continuation of *Introduction to COBOL Programming* with emphasis on the formulation and solution of typical data processing problems using a business-oriented language on a digital computer. The areas dealt with include sorting techniques, inventory accounting, and payroll calculations. The student is taught advanced language concepts and applications. Familiarity with direct access and indexed sequential file process-

ing, writing and linking to subprograms, sorts, and report writer is stressed.

Computer Operations

This course offers "hands-on" time during which the students practice the operations studied in *Introduction to Programming*. If possible, on-the-job training is given by assigning the student as an apprentice to site operators.

Programming Projects

A project course designed especially for students who are preparing for a career in programming. Students are required to solve actual data processing problems. In so doing, they acquire substantial work experience in applying the principles of systems analysis and design, programming in several computer languages, program testing and debugging, and program documentation.

EDP PERIPHERAL EQUIPMENT OPERATION (OBJECTIVE: JOB ENTRY)

Beginning Keypunch

An introductory course in keypunch operation designed to give the typist beginning skills in card punching and machine operation. Drills and exercises to develop punching accuracy and speed are included. Prerequisite: typing speed of 30 words per minute.

Keypunch and Data Entry

This course follows *Beginning Keypunch* and provides sophisticated drills in advanced keypunch and verifier operation, program card design and preparation, and direct data entry techniques. From practical experience, the student learns what happens to the cards after they have been punched.

Punched Card Data Processing I, II

An introduction to the punched card equipment that makes mechanized accounting systems possible. Practice problems provide actual experience in the operation of the sorter, collator, interpreter, reproducing punch, and accounting machines. Students work problems and convert the results to machine functions. The capabilities and applications of each unit record machine are presented and related to business data processing.

Office Machines

This course acquaints students with the machines most commonly used in a business office: dictaphone, adding machine, and calculator. Students gain additional skills in computation, speed drills, percentages, discounts and net values, chain discounts, and business forms. The course attempts to integrate business machine skills, typewriting, bookkeeping, arithmetic, and business writing.

Introduction to COBOL Programming

A beginning course in business programming. Business practices and the use of a business-oriented language, COBOL, are emphasized. Included is practice in the functions of the language instruction set, flow-charting, and non-scientific problem solving. File processing is limited to sequential files. The course is designed to give the student adequate business programming experience and the use of a programming language.

Computer Operations

This course provides "hands-on" time during which the student becomes familiar with basic computer operations. Wherever possible, on-the-job training is given by assigning the student as an apprentice to a site operator.

Curriculum Content and Relationships

This curriculum has been designed to meet the following educational objectives:

- Acquaint all high school students with computer capabilities and applications.
- Provide certain high school students with problem-solving tools with which to challenge further study.
- Prepare certain high school students for job entry in specific data processing positions.

Because of this diversity of goals, selection of course content and the organization of the recommended curriculum constitute a complex task. In addition, the sequence of courses is as crucial as

the content if the limited time available is to be used with maximum effectiveness. To this end, the subject matter is arranged in groups of concurrent courses coordinated to progress smoothly from one sequence to the next. Students thus gain a deeper understanding of basic principles while broadening their understanding of the many facets of computer science and data processing.

The curriculum has been designed to be offered on a semester school calendar. Most of the courses are designed to meet daily, with time divided appropriately between classroom and laboratory experiences.

The relationship between laboratory exercises and classroom lectures is of great importance. There must be direct correlation between the material presented in theory and terminology lectures and applications taught in the laboratory. Laboratory work can begin before the student is fully familiar with the underlying theory. As soon as the theory is clearly understood by the students it can be incorporated into the laboratory work.

For those students anticipating immediate job entry, Business Math and Business English are strongly recommended as substitutes for the last semester of the mathematics and English requirements. Further, Accounting has been included as a required part of the curriculum for these students. Since many of the courses that follow will build on concepts introduced in Accounting, Accounting should not be treated as an elective.

All course outlines are concise and comprehensive, but are offered as guides rather than specific instructional units to be covered in inflexible order. They represent a judgment as to the relative importance of each instructional unit, especially where time estimates are shown. It is expected that the principles stated in these courses will be reinforced with relevant applications. Field trips can add materially to the effectiveness of the instruction if they are carefully planned in advance to insure that the processes observed will be meaningful and relevant to the classroom and laboratory material being studied at the time of the trip.

Cooperative Vocational Education Programs

A curriculum which seeks to prepare students for job entry frequently can be strengthened by alternating classroom and laboratory study with carefully planned and coordinated paid employment experience. This is known commonly as cooperative vocational education or a cooperative program.

Cooperative programs offer special advantages to the student, although they may extend the length of the organized program. While employment projects can be, and often are, scheduled during a summer period, they may also intervene between the fall and spring semesters. Their principal benefits derive from actual working conditions the student will experience after graduation. Cooperative programs make it possible for students to use the equipment and perform the technical work required of their specialty under professional supervision and with personal responsibility commensurate with their capabilities.

The cooperative experience must be planned and supervised in accordance with a formal agreement between the school and the organization where the student will work. The agreement provides for specific duties to be performed by the student, with supervisory responsibilities clearly defined for both the work itself and the educational elements involved in the work.

Cooperative programs keep the curriculum up-to-date and realistic in terms of the personnel and training requirements of employers. They provide a highly effective conduit for graduate placement and special motivation for students in the form of monetary returns as they develop their skills and acquire confidence in their competence on the job.

Some special administrative considerations in cooperative programs are:

1. Employment opportunities must be found with employers sincerely interested in providing work training and educational experience for the student. Agreements must be negotiated for scheduled work, on-the-job supervision and performance evaluation, rates of pay, and travel expenses, if any.
2. Students must be available and ready when needed to fit into the employer's organization at regular intervals to perform scheduled work.
3. A school coordinator must be provided to plan the program of work and, by agreement with the employer, to visit, evaluate,

and counsel the students on the job. This work cannot be required of the staff in addition to its full-time teaching program at the school. Close supervision is required to help the students adjust to the work situation and meet the reasonable expectations of the employer. With the understanding of the employer, the work must never be allowed to become routine production or service work with little or no new experience in the student's technical specialty.

4. Students should be required to do a limited amount of organized study while on the job. Often this is a daily diary of work activity, an account of the week-by-week development of some technical aspect of the job, or a detailed analysis of the progress of some project on which the student is working.

5. The employer's evaluation of students' work and attitudes should be sought and recorded with the objective of assisting the students, maintaining satisfactory relationships with the employer, and counseling students in the important elements of success in an employment situation.

The characteristics of work projects are highly variable; each such project is unique. For this reason, it is not feasible to present in this guide a detailed course or project outline for a cooperative program. When a program is developed in light of local circumstances, planned with care, and supervised closely, it can contribute significantly to the education and training of a student whose goal is job entry competency.

Departments of vocational education in State governments should be contacted for data on regional and local cooperative programs.

INSTRUCTIONAL UNITS

ADVANCED COBOL PROGRAMMING

Periods Per Week: 5

Class, 3; laboratory, 2

Description

This course, a continuation of *Introduction to COBOL Programming*, makes use of more advanced concepts of COBOL. These include table handling, linking programs, report writer, the internal sort, and direct access file handling. Numerous business-oriented problems are assigned, each requiring one or more programs.

Major Divisions

		Hours Class	Hours Laboratory
I.	Review of Basic Concepts	1	0
II.	Indexed Sequential Files	8	5
III.	Table Handling, Linking Programs, and Additional Verbs	8	4
IV.	System and Private Libraries	4	3
V.	Introduction to American National Standard COBOL	6	0
VI.	Report Writer Feature	12	10
VII.	The COBOL Sort	8	4
VIII.	Additional Problem Assignments	1	6
	Total	48	32

I. Review of Basic Concepts
- A. Hexadecimal numbering system
- B. Sequential file processing
  1. Unit record devices
  2. Utility devices

II. Indexed Sequential Files
- A. Units of instruction
  1. Concepts
     a. Theory
     b. Need
     c. Applications
  2. Components
     a. Main data area
     b. Index area
     c. Cylinder overflow area
     d. Independent overflow area
  3. ISAM and COBOL statements
     a. Select
     b. Organization
     c. Random access
     d. Sequential access
     e. Reserve clause
     f. Record key
     g. Symbolic key
  4. Job control for ISAM files
     a. LBLTYP
     b. Multiple EXTENT(s)
- B. Laboratory
  1. Write and execute a COBOL program to randomly retrieve selected records from an ISAM file.
  2. Write and execute three COBOL programs
     a. Build an ISAM file.
     b. Add records to the ISAM file.
     c. List the ISAM file.

III. Table Handling, Linking Programs, and Additional Verbs
- A. Units of instruction
  1. Two-dimensional tables
  2. Three-dimensional tables
  3. Additional verbs for handling tables
     a. Perform/varying
     b. Go to . . . depending
     c. Exit
     d. Nested performs
  4. Linking programs
     a. Enter linkage
     b. Call
     c. Enter COBOL
- B. Laboratory
  1. Write and execute a COBOL program that will link to the supplied ALC program and produce a payroll register. Card input will contain social security number, name, number of dependents, marital status, gross pay, YTD FICA, and YTD gross.
  2. Using a three-dimensional table, accumulate enrollment figures, and produce an enrollment report. Each input card will contain data on 16 students. Produce a report by grade, year, and sex.

IV. System and Private Libraries
   A. Units of instruction
      1. Source statement library
         a. Theory
         b. Uses
         c. Exec maint
         d. Catals C bookname
         e. Bkend
         f. Copy 'bookname'
      2. Core image library
         a. Theory
         b. Uses
         c. Option catal
         d. Phase progname, S + O
         e. Exec progname
   B. Laboratory and semester assignment
      Program a disk-oriented payroll system that will accommodate changes, additions, time cards, etc. Periodically produce a list of additions, a list of changes, payroll register, and payroll checks. After testing each program, catalogue it in the core image library and thereafter execute it with call cards. All record descriptions should be catalogued in the source statement library.

V. Introduction to American National Standard COBOL
   A. Special registers
      1. Tally
      2. Current date
      3. Time-of-day
      4. Com-reg
   B. Identification division
      1. ID
      2. Date compiled
   C. Environment division
      1. Special names
      2. Select statement
   D. Data division
      1. Pic
      2. Just
      3. Editing
      4. Comp, comp-3
   E. Procedure division
      1. Implied operands
      2. Examine . . . tallying
      3. Start
      4. Write . . . advancing
      5. Write . . . positioning

VI. Report Writer Feature
   A. Units of instruction
      1. Concepts
      2. Data division considerations
         a. RD
         b. Controls
         c. Page
         d. Line
         e. Next group
         f. Type
         g. Column
         h. Group
         i. Reset
         j. Source
         k. Sum
      3. Procedure
         a. Initiate
         b. Generate
         c. Terminate
         d. Use before reporting
         e. Declaratives
   B. Laboratory
      1. Using report writer, write a COBOL program to produce a simple inventory listing.
      2. Using report writer, write a COBOL program to produce a contribution report by department.
      3. Using report writer, write a COBOL program to produce a cash transaction report using tape input. Input will be in ascending sequence by account number by date. Take control totals by account number by date.

VII. The COBOL Sort
   A. Units of instruction
      1. Environment division — select statement
      2. Data division — SD entry
      3. Procedure division
         a. SORT
         b. Ascending/descending
         c. Input procedure
         d. Output procedure
         e. Release
         f. Return
   B. Laboratory
      Write a COBOL program to build a sequential disk file using card input. Then, using

the COBOL sort, sort the file into zip code sequence, and produce an address listing using report writer.

VIII. Additional Problem Assignments

A. Write a COBOL program to reverse names. For example, John R. Smith should appear as Smith, John R.

B. Write a single COBOL program to build a sequential disk file, sort it into a different sequence, and produce an inventory listing using report writer.

Texts and References

Appropriate hardware manufacturers' manuals may be required for teaching and reference use in addition to materials that can be selected from the publications suggested below or from other sources.

BERNARD. *System/360 COBOL.*

CASHMAN. *Introduction to Computer Programming System/360 COBOL.*

FEINGOLD. *Fundamentals of COBOL Programming.*

MCCAMERON. *COBOL Logic and Programming.*

MCCRACKEN. *A Guide to COBOL Programming.*

STERN AND STERN. *COBOL Programming.*

BEGINNING KEYPUNCH

Periods Per Week: 5

Class, 1; laboratory, 4

Description

This introductory course in keypunching is designed to give the typist beginning skills in card punching and in machine operation. Drills and exercises to develop punching accuracy and speed are included. Special emphasis is placed on efficient use of the numeric keyboard and on the use of correct operating procedures for the keypunch and the verifier.

Major Divisions

		Hours Class	Hours Laboratory
I.	Orientation	1	4
II.	Introduction to Keypunching	1	4
III.	Keypunch Terminology	1	4
IV.	The Punch Card	1	4
V.	Reading the Punched Card	1	4
VI.	Taking a Card Count	1	4
VII.	Hardware Operating Features	1	4
VIII.	Keypunch Operation	1	4
IX.	The Program Drum	1	4
X.	Finger Position and Dexterity Activities	1	4
XI.	The Program Card	1	4
XII.	The Program Coding	1	4
XIII.	The Verifier	1	4
XIV.	Alternate Programming	1	4
XV.	Punching Computer Programs	1	4
XVI.	The Card Punch and the Card Verifier	1	4
	Total	16	64

I. Orientation
- A. Units of instruction
  1. Operation of keypunch machine
  2. Operation of verifier
  3. Understanding of machine capabilities
- B. Laboratory
  Exercises based on preceding units of instruction

II. Introduction to Keypunching
- A. Units of instruction
  1. Background to the concepts of data processing
  2. Types of keypunch machine
  3. Types of verifier
- B. Laboratory
  Exercises based on preceding units of instruction

III. Keypunch Terminology
- A. Units of instruction
  1. Terms commonly used in keypunch machine operations
     a. Zone punch
     b. A/N
     c. X-punch
     d. Field
     e. Alpha
     f. Numeric
  2. Terms commonly used by programmers to give instructions to keypunch operators
     a. Dup
     b. PWZ
     c. FWZ
     d. DNP
     e. L/J
     f. R/J
- B. Laboratory
  Exercises based on preceding units of instruction

IV. The Punch Card
- A. Units of instruction
  1. History of the punch card
  2. Characteristics of the punch card
     a. Eighty columns
     b. Twelve-edge
     c. Nine-edge
     d. Zone punches
     e. Digit punches
     f. One-column end
     g. Eighty-column end
     h. Row
     i. Column
- B. Laboratory
  Exercises based on preceding units of instruction

V. Reading the Punched Card
- A. Units of instruction
  Concept of zone with digit punches to form a specific character
- B. Laboratory
  When given uninterpreted punched cards, students will interpret the cards' meaning by the punches.

VI. Taking a Card Count
- A. Units of instruction
  1. Keeping an account of punched cards by the use of:
     a. Ruler
     b. Card gauge
- B. Laboratory
  Given various card stack measurements, students will determine the approximate number of cards represented.

VII. Hardware Operating Features
- A. Units of instruction
  1. Parts of machine
     a. Hopper
     b. Punching station
     c. Reading station
     d. Card stacker
     e. Reading board
     f. Program unit
     g. Backspace key
     h. Program control lever
     i. Chip box and fuses
     j. Printing mechanism
  2. Components of the program unit
     a. Program drum
     b. Sensing mechanism
     c. Column indicator
  3. Functional keys
     a. Mult pch
     b. Dup
     c. Skip
     d. Rel
     e. Feed
     f. Reg
     g. Num
     h. Alpha
     i. Space bar
  4. Functional control switches
     a. Auto feed
     b. Auto skip/auto dup
     c. Print
- B. Laboratory
  Exercises based on preceding units of instruction

VIII. Keypunch Operation
- A. Units of instruction
  1. Starting a keypunch operation
  2. Stopping a keypunch operation
  3. Clearing the card bed
  4. Removing a card from the punching or reading station
  5. Multiple-punched columns
  6. X-punching and skipping
  7. Corner cuts
  8. Single card feeding
  9. Keyboard locking
  10. Suspending automatic duplication of the first card
- B. Laboratory
  Exercises based on preceding units of instruction

IX. The Program Drum
- A. Units of instruction
  1. Concept of the program drum
  2. Purpose of the program drum
  3. Correct positioning of the program card on the drum
- B. Laboratory
  Exercises based on preceding units of instruction

X. Finger Position and Dexterity Activities
- A. Unit of instruction
  Finger positions on alphanumeric keyboard
- B. Laboratory
  Finger positioning exercises on alphanumeric keyboard

XI. The Program Card
- A. Units of instruction
  1. Concept of the program card
  2. Program planning
  3. Layout card
- B. Laboratory
  1. Prepare a layout card for an invoice.
  2. Prepare a program card for an invoice.

XII. The Program Coding
- A. Units of instruction
  Codes common to normal programming
- B. Laboratory
  1. Aided by program control, learn the location of numeric keys.
  2. Using automatic duplication, keypunch an invoice.
  3. Keypunch a cost report.
  4. Keypunch a spread card operation.
  5. Keypunch journal numbers, account numbers, and customer numbers from adding machine tapes.

XIII. The Verifier
- A. Units of instruction
  1. Operating features
  2. Correct operating procedures
- B. Laboratory
  1. Verify numeric exercises with the aid of program cards.

2. Verify name and address exrcises, using alternate verifying operations.

XIV. Alternate Programming
- A. Units of instruction
  1. Use of program two
  2. Codes common to alternate programming
- B. Laboratory
  1. Using alternate programming and credit X punches, prepare invoice sales reports.
  2. Prepare name and address cards.

XV. Punching Computer Programs
- A. Units of instruction
  1. Fundamentals of coding sheet
  2. Special instructions and symbols
- B. Laboratory
  Using COBOL language, prepare computer programs.

XVI. The Card Punch and the Card Verifier
- A. Units of instruction
  1. Operating features
  2. Functional switches
- B. Laboratory
  1. Program and keypunch a payroll.
  2. Using the verifier, program the cards for automatic verification.

Texts and References

Appropriate hardware manufacturers' systems operating manuals are required for teaching or for reference use in addition to materials that may be selected from the list of suggested publications below or from other sources.

CLAFFEY. *Keypunch Operation.*

HANSON. *Keypunching.*

KEYS AND POWELL. *A Handbook of Modern Keypunch Operation.*

PAYNE AND PAYNE. *Easily Applied Principles of Keypunching.*

PAYNE AND PAYNE. *Practice Lessons for Keypunching.*

PACTOR-KARGILIS. *Card-Punch Machine Operation.*

BUSINESS APPLICATIONS DEVELOPMENT

Periods Per Week: 5

Class, 2; laboratory, 3

Description

It is assumed that students will have been familiarized with FORTRAN in the introductory course, *FORTRAN Applications Programming*. This course will review FORTRAN and then will progress to increasingly sophisticated applications that are particularly relevant to the business world. Emphasis will be placed on the development of commercial problem-solving procedures that are to be computerized and to describing these procedures by the use of flow charts. Some of the concepts to be covered are procedure execution, loop structure, subscripted variables, creation and use of subprograms and subroutines, and data storage and retrieval. Students will define, flow chart, code, and test several programs, beginning with problems that require simple reports and concluding with preparing payroll and accounts receivable programs.

Major Divisions

		Hours	
		Class	*Laboratory*
I.	Computer Problem Solving	2	3
II.	FORTRAN IV Language Elements	5	7
III.	Loops and Arrays	3	7
IV.	Specifications	2	1
V.	Subroutines and Subprograms	4	8
VI.	Debugging	2	1
VII.	Data Storage and Retrieval	5	8
VIII.	Formal Definition Framework	3	1
IX.	Business Computing Techniques	6	12
	Total	32	48

I. Computer Problem Solving
  A. Units of instruction
    1. Problem definition
    2. Flow charting
      a. Program flow chart
      b. System flow chart
    3. Programming
    4. Debugging
    5. Applying the framework
  B. Laboratory
    Given a system flow chart and descriptions of several problems, write problem definitions and develop flow charts to solve the problems.

II. FORTRAN IV Language Elements
  A. Units of instruction
    1. Basics
      a. Character set
      b. Statement types
      c. Card format
      d. Constants and variables
      e. Operators and expressions
      f. Program termination
    2. Input/Output
      a. Format
      b. Write
      c. Read
      d. Implied DO
      e. Name list
    3. Decision making and branching
      a. Unconditional GO TO
      b. Arithmetic IF
      c. Logical IF
      d. Computed GO TO
      e. Assigned GO TO
  B. Laboratory
    1. Re-write a given list of arithmetic expressions in the FORTRAN form.
    2. Prepare a program that uses basic logic and accents input and output.
    3. Prepare a program that implements several conditional branches.

III. Loops and Arrays
  A. Units of instruction
    1. DO and continue
    2. Arrays
      a. One-dimensional
      b. Two-dimensional
      c. Three-dimensional
  B. Laboratory
    1. Solve a problem that makes use of a one- or two-dimensional array. For example, reverse the numbers in a 25-element array.
    2. Solve a problem that makes use of a two- or three-dimensional array; for example, matrix multiplication.

IV. Specifications
  A. Units of instruction
    1. Explicit type statements
      a. Integer
      b. Real
      c. Double precision
    2. Implicit statement
    3. Equivalence statement
  B. Laboratory
    Techniques developed in the preceding units of instruction will be implemented in the programs of other units.

V. Subroutines and Subprograms
  A. Units of instruction
    1. Predefined subroutines
    2. Assignment statement
    3. Function subprograms
    4. Subroutine subprograms
    5. Common
      a. Unlabeled
      b. Labeled
  B. Laboratory
    1. Solve a problem utilizing predefined subroutines and an assign statement subroutine.
    2. Given appropriate parameters, prepare a subroutine subprogram, such as computing an individual's income tax.

VI. Debugging
  A. Units of instruction
    1. Verification of programs (bench checking)
    2. Facility available
    3. Sources of information
  B. Laboratory
    Discuss topics presented in this unit. Related techniques will be implemented in the programs of the other units of instruction.

VII. Data Storage and Retrieval
  A. Units of instruction
    1. Sequential tape — input and output
    2. Direct access (disk) — input and output
  B. Laboratory
    Prepare a tape- or disk-oriented payroll program. (This should be a more complex problem typifying common techniques used in commercial world.)

VIII. Formal Definition Framework
  A. Units of instruction
    1. Generic
    2. Operational
    3. FORTRAN IV statements
  B. Laboratory
    Discuss the definitions presented earlier in order to strengthen understanding of the FORTRAN IV language.

IX. Business Computing Techniques
  A. Units of instruction
    1. Sorting
    2. Merging
    3. Searching
    4. FORCOM
      a. Floating dollar sign
      b. Alphameric move and compare
      c. Reading of unformatted records
      d. Character editing
  B. Laboratory
    1. Prepare a sort of information that is stored in arrays in core or on tape or disk. The information could be the names of customers who have accounts with a company.
    2. Prepare a tape merge program. This could represent combining a new customer file with the master customer file.
    3. Search an ordered disk file for a valid customer when an item is charged to an account.

Texts and References

Appropriate hardware manufacturers' manuals may be required for teaching and reference use in addition to materials suggested below or available from other sources.

EMERICK AND WILKINSON. *Computer Programming for Business and Social Science.*
GOLDEN. *FORTRAN IV Programming and Computing.*
NOLAN. *FORTRAN IV Computing and Applications.*

COMPUTER OPERATIONS

Periods Per Week: 5

Class, 3; laboratory, 2

Description

This course is designed to provide the student with practical understanding of a computer system by affording hands-on experience in operating a computer. Operating concepts are covered in the classroom, and time at the computer center is structured to emphasize the development of specific skills and of general knowledge of sound operating procedures. Laboratory time is scheduled so that only a few students are in the center during each period of hands-on training. Whenever possible, each student should be assigned as an apprentice to a site operator. If on-site equipment is not available, students should substitute *Programming Projects* or an appropriate elective.

Major Divisions

	Hours	
	Class	*Laboratory*
I. Computer Concepts	9	1
II. Computer Devices and Operations Concepts	9	1
III. The Operator and the Computer System	6	6
IV. System Procedures	12	12
V. Operating System Techniques	12	12
Total	48	32

I. Computer Concepts
   A. Units of instruction
      1. Basic operational concepts
      2. Data recording media
      3. Storage
   B. Laboratory Projects
      Observe operations in the computer center.

II. Computer Devices and Operating Concepts
   A. Units of instruction
      1. Central processing unit
      2. I/O devices
      3. Stored program concepts
      4. Programming languages
      5. Operating systems
   B. Laboratory Projects
      Demonstrate individual hardware items in the computer center.

III. The Operator and the Computer System
   A. Units of instruction
      1. Introduction to operation
      2. Role of the operator
      3. Reader, punch, printer
      4. Tape drives
      5. Direct access devices
      6. CPU and console typewriter
   B. Laboratory Projects
      Observe and assist the operator, either singly or in small groups.

IV. System Procedures
   A. Units of instruction
      1. IPL procedures
      2. LUB and PUB
      3. Job control
      4. Batch jobs
      5. Multiprogramming
   B. Laboratory Projects
      Continue assisting the operator; prepare the JCL for simple jobs, and run them.

V. Operating System Techniques
   A. Units of instruction
      1. DOS run procedure
      2. Linkage editor
      3. OS run procedure
      4. Utilities
      5. Job streams
      6. POWER
   B. Laboratory Projects
      Run typical jobs under the supervision of regular operators, and continue to observe and assist in the computer center.

Texts and References

Although the IBM System/360 was in use for the design and testing of this course, the course outline can be used as a guide in preparing instructional material for use with other computer systems. Text and reference material should include appropriate operating manuals prepared by the hardware manufacturer.

FORTRAN APPLICATIONS PROGRAMMING

Periods Per Week: 5

Class, 3; laboratory, 2

Description

This course, intended as a first course in FORTRAN programming, emphasizes the fundamental principles of developing simple alogrithms, while also emphasizing flow charting and coding programs in a modern higher level language. The course is designed for five meetings each week with the basic material being covered in twelve weeks. The last four weeks are devoted to applications and enrichment material.

As a prerequisite, students should show reasonable proficiency in mathematics and should be capable of taking Algebra II concurrently with this course.

Major Divisions

	Hours	
	Class	*Laboratory*
I. Introduction and Orientation	5	0
II. Alogrithms and Flow Charts	6	4
III. Programming with FORTRAN	22	18
IV. Applications and Enrichment Material	15	10
Total	48	32

I. Introduction and Orientation
   - A. What computers are and do
   - B. A brief history of computers
   - C. Types of FORTRAN application
   - D. Scope and intent of course

II. Alogrithms and Flow Charts
   - A. Units of instruction
     1. Logical solutions to problems
     2. Simple alogrithms
     3. Building alogrithms
     4. Flow-charting alogrithms
   - B. Laboratory
     1. Discuss the use of terminals; tour a computer center.
     2. Flow-chart and write a program that will convert Fahrenheit temperatures to centigrade.
     3. Flow-chart and write a program that will accept a number from the terminal and print out the number, its square root, square, and cube.

III. Programming with FORTRAN
   - A. Units of instruction
     1. Elements and properties of FORTRAN
     2. Sample programs involving simple decisions
     3. Programs with external input
     4. Basic loops
     5. Use of the integer function
     6. Loops with decisions and variable loops
     7. Nested loops
     8. One-dimensional arrays
     9. Two-dimensional arrays
     10. Review
     11. Enrichment material
   - B. Laboratory
     1. Flow-chart and write a program that will accept hours worked and the hourly rate from the terminal and will calculate the wages. Allow "time-and-a-half" for overtime.
     2. Flow-chart and write a program that will calculate postage, given the weight and class.
     3. Flow-chart and write a program that will find the greatest common divisor given two integers.
     4. Using variable loops, flow-chart and write a program that will calculate the compound interest, given principal, rate of interest, and time.
     5. Flow-chart and write a program that will print out the multiplication tables from 1×1 through 10×10.
     6. Flow-chart and write a program that will calculate and store the first twelve Fibonacci numbers in an array and then will print out the numbers.
     7. Rewrite the multiplication table problem so that the table is stored in an array and then printed out.

IV. Applications and Enrichment Material
   Topics are left to the discretion of the instructor, but they should be limited to material needed to introduce and define new problems.

Texts and References

FARINA. *Fortran IV Self-Taught.*

FORD. *Basic Fortran IV Programming.*

HEALY AND DEBRUZZI. *Basic FORTRAN IV Programming.*

MURRILL AND SMITH *Introduction to FORTRAN IV Programming.*

ORGANICK. *A FORTRAN IV Primer.*

INTRODUCTION TO COBOL PROGRAMMING

Periods Per Week: 5

Class, 3; laboratory, 2

Description

This beginning course in business programming emphasizes business practices and the use of a business-oriented language, COBOL. Included is practice in the functions of the language instruction set, flow charting, and nonscientific problem solving. File processing is limited to sequential files. The course is designed to give the student business programming experience and the use of a programming language.

Major Divisions

		Hours	
		Class	*Laboratory*
I.	Review of Hexadecimal and Flow Charting	2	3
II.	Identification Division	1	3
III.	Environment Division	2	3
IV.	Data Division, File Section	4	5
V.	Data Division, Working-Storage Section	4	5
VI.	Procedure Division	3	4
VII.	Job Control Language	2	3
VIII.	COBOL Diagnostics and Debugging Features	2	5
IX.	Business Applications and Additional COBOL Specifications	12	17
	Total	32	48

I. Review of Hexadecimal and Flow Charting
- A. Units of instruction
  1. Hexadecimal numbering system
     a. Explanation and concept
     b. Decimal to hexadecimal conversion
     c. Hexadecimal to decimal conversion
     d. Addition of hexadecimal numbers
     e. Subtraction of hexadecimal numbers
  2. Flow charting review
  3. General explanation of the COBOL language
     a. Overview
     b. COBOL coding sheet
     c. Reserved words
     d. Numeric literals
     e. Non-numeric literals
- B. Laboratory
  1. Solve the following:
     a. Decimal to hexadecimal conversion
     b. Hexadecimal to decimal conversion
     c. Addition of hexadecimal numbers
     d. Subtraction of hexadecimal numbers
  2. Construct a flow chart to solve problems.
  3. Study a list of COBOL words.

II. Identification Division
- A. Units of instruction
  COBOL entries:
  1. Program ID
  2. Author
  3. Installation
  4. Date written
  5. Date compiled
  6. Security
  7. Remarks
- B. Laboratory
  Write and keypunch the identification division for a card-to-printer inventory report. The deck should be retained to use later.

III. Environment Division
- A. Units of instruction
  1. Configuration section
     a. Source computer
     b. Object computer
  2. Input/output section
  3. File control
     a. Select statement
     b. Assign
     c. Access
  4. I/O control — apply statement
- B. Laboratory
  Write and keypunch the environment division for a card-to-printer inventory listing. Retain the deck for later use.

IV. Data Division, File Section
- A. Units of instruction
  1. File description entry
     a. FD
     b. Recording mode
     c. Label records clause
     d. Data record clause
  2. Level numbers
     a. 01
     b. 02 - 49

3. Assignment of data names
4. Picture clause
5. Types of data — usage clause
   a. External decimal or zoned decimal
   b. Packed decimal — computational-3
   c. Binary — computational
   d. Floating point — computational-1 and -2

B. Laboratory
Write and keypunch the file section for the inventory program already started. The following fields will be in each data card: item number, quantity on hand, quantity on order, and quantity requested. All quantity fields will be used in calculation Retain the deck for later use.

V. Data Division, Working-Storage Section
A. Units of instruction
1. Level 77 entries
   a. Explanation
   b. Format
   c. Value clause
2. 01 record description entries and subsequent levels
3. Report items and editing
   a. Fixed symbols
   b. Floating symbols
4. Level 88 entries

B. Laboratory
Write and keypunch the entire working-storage section, including 77's, and print lines for the inventory program. Allow for totals for all quantity fields, and calculate the total number that should be in stock after all orders have been received and filed. Use the formula: quantity on hand + quantity on order = quantity requested. Retain the deck for later use.

VI. Procedure Division
A. Units of instruction
1. I/O statements
   a. OPEN
   b. CLOSE
   c. READ
   d. WRITE
2. Data manipulation and arithmetic statements
   a. MOVE (all options)
   b. ADD
   c. SUBTRACT
3. Conditional expressions and statements
   a. Overflow test
   b. IF
4. Sequence control
   a. STOP
   b. GO TO
   c. Simple perform

B. Laboratory
Using the flow chart written during the first week and the information furnished thus far, write and keypunch the procedure division for the inventory problem. Retain the deck and the coding sheets for later use.

VII. Job Control Language
A. Units of instruction
1. Job statement
2. Option statement
   a. LINK
   b. LIST
   c. LOG
   d. LISTX
   e. SYM
   f. DUMP
3. EXEC COBOL
4. EXEC LNKTST
5. EXEC LNKEDT
6. EXEC
7. Miscellaneous JCL

B. Laboratory
Prepare all JCL necessary to compile the inventory program. Combine all previous decks into a single program ready for compilation; a deck for a program assembly is not required at this time.

VIII. COBOL Diagnostics and Debugging Features
A. Units of instruction
1. Explanation of diagnostics
2. Types of diagnostics
3. Debugging statements
   a. TRACE
   b. ON (count)
   c. EXHIBIT
   d. DISPLAY
4. Procedure map

B. Laboratory
Submit the inventory program for compilation; make corrections until the program executes properly.

IX. Business Applications and Additional COBOL Specifications
A. Units of instruction

1. Additional data division entries
   a. Block contains
   b. Record contains
   c. Redefines
   d. Occurs
   e. Blank when zero
2. Additional procedure division entries
   a. REWRITE
   b. ACCEPT
   c. DISPLAY
   d. MULTIPLY
   e. DIVIDE
   f. Compute
   g. Relation test
   h. Sign test
   i. Class test
   j. Condition test
   k. GO TO . . . depending
   l. Nested performs
   m. EXIT
   n. Note
3. Additional job control language
   a. ASSGN
   b. T1B1
   c. D1B1
   d. Extent

B. Laboratory
1. Write, keypunch, and execute a COBOL program to produce a payroll register using card input. Input cards will contain: week number, employee name and number, tax class, YTD gross, YTD FIT, QTR FICA, and gross pay. Calculate FICA and FIT using appropriate formulas. Accumulate totals for all significant amounts.
2. Complete the processes:
   a. Write, keypunch, and execute a COBOL program to build a sequential disk file from card input.
   b. Write a COBOL program to list the file specified in the preceding paragraph.
3. Write, keypunch, and execute a COBOL program to produce a cash transaction report using tape input. Input will be in ascending sequence by account number by date. Take control totals by account number and date.
4. Write, keypunch, and execute a COBOL program that will produce an updated master file using two disk files (master and detail) as input. If the master and detail account numbers match, update the master accordingly. If a master record has no matching details, it should be retained; if a detail has no matching master, create a new master from the first detail, and update it with any subsequent matching details.
5. Complete the processes:
   a. Write, punch, and execute a COBOL program that will use as input the disk file previously built and write selected records to tape.
   b. List the entire tape file on the printer.

Texts and References

Appropriate hardware manufacturers' systems operating manuals and programmer's guides are required for teaching or for reference use in addition to materials that may be selected fom the list of suggested publications below or from other sources.

FEINGOLD. *Fundamentals of COBOL Programming.*
MCCAMERON. *COBOL Logic and Programming.*
MCCRAKEN AND GARBASSI. *A Guide to COBOL Programming.*
MURRILL AND SMITH. *An Introduction to COBOL Programming.*
SPITZBARTH. *Basic COBOL Programming.*
STERN AND STERN. *COBOL Programming.*

INTRODUCTION TO COMPUTERS

Periods Per Week: 3

Class, 3

Description

This reading course is intended to present a broad view of the computer and its applications. Course materials are selected that will assist students to achieve literacy in computer capabilities and encourage them to evaluate their career goals and to plan their future studies. A selected reading list is assigned for class study; students are expected to present their reactions in a written report or in an oral presentation and discussion with the class.

Major Divisions

		Class Hours
I.	*The Digital Villain*	12
II.	*Computers and Their Uses*	12
III.	*Expanding Use of Computers in the 70's: Markets, Needs, Technology*	12
IV.	*Computers and Society*	12
	Total	48

I. *The Digital Villain*
- A. A view from within: the golden bit
  1. The semantics of computer science
  2. Computer history
  3. Turing's mini super-computer
  4. The road to bitsville
  5. The golden bit
  6. Games computers play
  7. Playing the games
  8. Artificial intelligence and intelligent artifice
- B. A view from without: the digital villain
  1. Man as machine
  2. Man vs. machine — the last victory
  3. The computer as espionage agent
  4. The computer as lover
  5. The computer as sportsman, moralist, and writer
  6. The computer as the military/scientific establishment
  7. 2001: the computer as travelling companion
  8. How the opposition sees man

II. *Computers and Their Uses*
- A. Social value of intelligent machines
- B. Evolution of data processing
  1. Organization and functions of computers
  2. Representation of information
  3. Machine logic
  4. Algebra of automata
  5. Elements of programming
  6. Magnetic tape operations
  7. Programming techniques
- C. Symbols of human striving
  1. Conquest of physical universe
  2. Real-time data processing
  3. Multiprogramming for real-time system
  4. Time-sharing systems
- D. Man-machine communications
  1. Computerization in the universities
  2. Role of computers in the just society
  3. Theory of automata
  4. Intelligence in the cosmos

III. *Expanding Use of Computers in the 70's:* Markets, Needs, Technology
- A. Introduction and overview
- B. Emerging requirements: what users think they need
- C. Creating new markets: the expanding role of marketing
- D. The picture overseas
  1. Needs
  2. Technology
  3. Approach
- E. Special new markets

IV. *Computers and Society*
- A. Why study computers?
- B. What are computers?
- C. What is their influence on society?
- D. How can we control them?
- E. What about the future?

Texts and References

BAER. *The Digital Villain.*
DESMONDE. *Computers and Their Uses.*
GRUENBERGER. *Expanding Use of Computers in the 70's: Markets, Needs, Technology.*
ROTHMAN AND MOSMANN. *Computers and Society.*

INTRODUCTION TO PROGRAMMING

Periods Per Week: 5

Class, 3; laboratory, 2

Description

This course is designed to be the first programming course in the curriculum and no prior knowledge of computers or programming is assumed. The BASIC programming language and flow charting are introduced at the beginning of the course so that the student will have a better idea of what a computer does before investigating how it does it.

Approximately half of the lectures and nearly all of the laboratory exercises are devoted to programming and flow charting. Programming assignments in the laboratory will progress concurrently with the presentation of fundamental topics such as the historical development of computers, typical present day hardware, and software and computer applications.

Major Divisions

	Hours	
	Class	*Laboratory*
I. Introduction to Programming	24	*30
II. Computers Past and Present	6	2
III. Applications and Trends	18	0
Total	48	32

*NOTE: Laboratory assignments from major division I extend throughout the entire course.

I. Introduction to Programming
- A. Units of instruction
  1. Introduction and overview
  2. Alogrithms and flow charts
  3. Elements of the language
  4. Simple programs
     a. Conversion
     b. Simple input and output (I/O)
  5. Conditional statements
  6. Loops
     a. Simple loops
     b. Variable loops
     c. Nested loops
  7. Functions
  8. One-dimensional arrays
  9. Two-dimensional arrays
- B. Laboratory
  1. Visit a computer facility. This should not be a walk-through tour en masse; rather, students should be in small groups so that all can observe the operation and function of each major piece of hardware in the facility. If the school has no computer equipment, arrangements should be made with another institution, business, or industry to tour their facility.
  2. Practice flow-charting simple alogrithms such as printing out the even integers from 0 to 100 or reading a deck of cards and printing out their contents. Good flow-charting techniques are to be stressed and correct use of flow-charting symbols should be developed.
  3. Flow-chart and write a program that will perform a simple conversion table such as to convert Fahrenheit temperatures 12 through 212 degrees to centigrade equivalents at intervals of 10 degrees.
  4. Flow-chart and write a program that will accept numbers from the terminal or card reader and print out the number, its square root, square, and cube.
  5. Flow-chart and write a program that will calculate wages, given rate and time worked. Allow 'time-and-a-half for overtime.
  6. Rewrite the program described in paragraph 3 above or modify the program developed in paragraph 5 above to make use of loop instructions (FOR and NEXT in BASIC).
  7. Flow-chart and write a program to find the greatest common divisor of two integers.
  8. Flow-chart and write a program to calculate compound interest, given the deposit, rate of interest, and the time.
  9. Flow-chart and write a program to print out the multiplication table for 1×1 through 10×10, using nested loops.
  10. Flow-chart and write a program to assign values to the elements in a one-dimensional array, and print out the result. Example: store the first 20 numbers of the Fibonacci sequence and print them out.

11. Flow-chart and write a program to assign values to the elements of a two-dimensional array, and print them out.

II. Computers Past and Present
  A. Units of instruction
    1. History of computing machines
    2. History of electronic computers
    3. Numbering systems
      a. Binary
      b. Hexadecimal
    4. Computer organization
      a. Central processor organization
        (1) Main memory
        (2) Arithmetic and logic unit
        (3) Control unit
        (4) I/O control unit
      b. I/O devices
    5. Addressing
    6. Machine languages and assemblers
    7. Higher level languages
  B. Laboratory
    Review numbering systems. Practice using binary and hexadecimal arithmetic and converting from one number base to another.

III. Applications and Trends
  A. Applications in business
  B. Applications in science
  C. Trends in information processing
    1. In-house system
    2. Time sharing
    3. Service bureau
  D. Trends in programming languages
  E. Jobs in information processing

Texts and References

BARTEE. *Digital Computer Fundamentals.*

BOYES, SHIELDS AND GREENWELL. *Introduction to Electronic Computing: A Management Approach.*

FORSYTHE, KEENAN, ORGANICK, AND STENBERG. *Computer Science: A First Course.*

GERALD. *Computers and the Art of Computation.*

SPENCER. *A Guide to BASIC Programming: A Time-Sharing Language.*

STERLING AND POLLACK. *Computing and Computer Science.*

KEYPUNCH AND DATA ENTRY

Periods Per Week: 5

Class, 2; Laboratory, 3

Description

This course follows the introductory *Beginning Keypunch* and presents sophisticated drills in advanced keypunch and verifier operation, programmed card design and preparation, and direct data entry techniques. From practical experience gained in laboratory situations, students learn what happens to the input they prepare and how it relates to the total system. Special emphasis is placed on the efficient use of the alphameric keyboard and on correct operational procedures.

Major Divisions

		Hours	
		Class	*Laboratory*
I.	Introduction to Keypunch Operation	2	1
II.	The Punched Card	2	2
III.	Components of the Keypunch	4	4
IV.	Operation of the Keypunch	4	10
V.	Programming the Keypunch	2	10
VI.	Typical Keypunch Procedures	4	2
VII.	Keypunching Computer Programs	4	3
VIII.	The Card Verifier	4	10
IX.	Related Activities of the Keypunch Operator	6	6
	Total	32	48

I. Introduction to Keypunch Operation
  A. Units of instruction
    1. The keypunch operator
    2. The history of punched card data processing
    3. The machines used in punched card data processing
  B. Laboratory
    Exercises to determine proficiency in keypunching numeric data

II. The punched Card
  A. Units of instruction
    1. Identification of punched cards
    2. Hollerith code
    3. Card fields
    4. Design of punched cards
    5. Data coding
    6. The control punch
    7. Card reading
    8. Care and treatment of cards
    9. Fanning and joggling
  B. Laboratory
    Exercises in keypunching customer sales data in simulated on-the-job situations

III. Components of the Keypunch
  A. Units of instruction
    1. Characteristics
    2. Operating features
  B. Laboratory
    Making use of left-zero features in coding program cards and in keypunching purchase requisitions

IV. Operation of the Keypunch
  A. Units of instruction
    1. Keypunching without program control
    2. Keypunching procedures
    3. Removing card jams and unlocking the keyboard
  B. Laboratory
    Keypunching invoices from data prepared in longhand to give practice in using handwritten source documents

V. Programming the Keypunch
  A. Units of instruction
    1. The program drum and basic program control
    2. Coding the program card
  B. Laboratory
    1. Keypunch exercises making use of adding machine tapes as source documents
    2. Exercises in using a job instruction sheet and in keypunching plant and equipment data in order to become familiar with on-the-job environment

VI. Typical Keypunch Procedures
  A. Units of instruction
    1. Reading the job instruction sheet
    2. Procedures for common keypunching operations
    3. Ribbon replacement
  B. Laboratory
    1. Preparing alternate program cards to keypunch billing, using program one and program two
    2. Practice in replacing ribbons on the keypunch machine.

VII. Keypunching Computer Programs

A. Units of instruction
   1. Special symbols on the keypunch
   2. Computer languages

B. Laboratory
   Exercises in keypunching computer programs using various languages

VIII. The Card Verifier

A. Units of instruction
   1. Characteristics
   2. Operating features

B. Laboratory
   1. Preparing a program card to verify left-zero exercise, using the left-zero control key
   2. Preparing a program card and verifying billing, using alternate programs
   3. Verifying insurance billing, using credit X punch

IX. Related Activities of the Keypunch Operator

A. Units of instruction
   1. Data recorder
   2. Keytape
   3. Teletype units
   4. Magnetic data inscriber
   5. Hardware
   6. Future prospects
   7. Related activities

B. Laboratory
   Keypunching insurance billing, using the credit X punch

Texts and References

CLAFFEY. *Keypunch Operation.*
HANSON. *Keypunching.*
KEYS AND POWELL. *A Handbook of Modern Keypunch Operation.*
PAYNE AND PAYNE. *Easily Applied Principles of Keypunching.*
PAYNE AND PAYNE. *Practice Lessons for Keypunching.*
PRACTOR AND KARGILIS. *Card-Punch Machine Operation.*

OFFICE MACHINES

Periods Per Week: 5

Class, 3; laboratory, 2

Description

This course familiarizes students with commonly used business machines: the dictaphone, adding machine, and the calculator. Instruction then is directed to integrating business machine skills with typewriting, accounting, arithmetic, and business writing. Students also give attention to learning the use of business forms and to acquiring speed and accuracy in computing percentages, discount and net values, chain discounts, and other business procedures.

Major Divisions

		Hours Class	Hours Laboratory
I.	Dictaphone and Transcription	16	10
II.	Adding Machine	16	11
III.	Calculator	16	11
	Total	48	32

I. Dictaphone and Transcription
- A. Units of instruction
  1. Operation of transcription unit
  2. Elements of language
     - a. Period
     - b. Question mark
     - c. Comma
     - d. Apostrophe
     - e. Hyphen
     - f. Spelling rules
     - g. Suffixes
  3. Parts of the letter
     - a. Letterhead
     - b. Dateline
     - c. Heading
     - d. Inside address
     - e. Salutation
     - f. Body
     - g. Reference initials
  4. Letter styles
     - a. Full-blocked
     - b. Modified block
     - c. Simplified
  5. Standard business letters
     - a. Inquiry
     - b. Acknowledgment
     - c. Confirmation
     - d. Transmittal
     - e. Remittance
- B. Laboratory

  Transcribe materials that demonstrate the various elements of language and correspondence illustrated in the lesson.

II. Adding Machine
- A. Units of instruction
  1. Ten-key adding machines
     - a. Addition
     - b. Subtraction
     - c. Debit and credit balance
     - d. Percentage
     - e. Multiplication
     - f. Multiplication and addition
     - g. Chain discounts and percentage
  2. Full-key adding machines
     - a. Addition
     - b. Subtraction
     - c. Multiplication
     - d. Combination
- B. Laboratory

  Practice timed drills in actual business procedures such as processing invoices, inventories, bank statements, and payrolls.

III. Calculator
- A. Units of instruction
  1. Printing calculator
     - a. Addition
     - b. Subtraction
     - c. Multiplication
     - d. Division
     - e. Computation of interest and principal
     - f. Computation of discount and net amount
     - g. Three-factor multiplication
  2. Electronic calculators
     - a. Addition
     - b. Subtraction
     - c. Multiplication
     - d. Division

e. Computation of amount and percent of increase or decrease
f. Interest-bearing notes
g. Mutual funds constant dividends
h. Square root
i. Amortization schedule

B. Laboratory

Practice timed drills in various computations on the kinds of calculator described above.

Texts and References

BRIGGS AND KOSY. *Office Machines.*
GIORDANO. *Basic Business Machine Calculation.*
IBM. *Transcription Skills for Word Processing.*

PROCEDURES FOR ORGANIZING INFORMATION

Periods Per Week: 5

Class, 5

Description

Designing systems for business data processing requires a knowledge of business systems and procedures, the kinds of information required by management, the equipment available for processing data, and the techniques necessary to bring all these elements together. This course stresses these techniques and presents a thorough background for systems work and its allied areas.

Major Divisions

		Class Hours
I.	Systems Fundamentals	30
II.	Data Processing Equipment	10
III.	Techniques for Systems and Data Processing Applications	20
IV.	Business Procedures and Procedure Applications	20
	Total	80

I. Systems Fundamentals
- A. Internal business structure
  1. Line organization
  2. Line and staff organization
  3. Functional plan of organization
  4. Committee organization
- B. The systems department
  1. Scope of work
  2. Functions
  3. Administration
  4. Controls
     a. Workload sheets
     b. Project status and summary records
     c. Status folders
     d. Completed project reports
- C. Systems communications and instruction manuals
  1. Procedure writing
  2. Distribution of procedures and manuals
  3. Revisions in written procedures
- D. Forms management and records retention and management
  1. Forms management
  2. Forms analysis procedure
  3. Forms control and forms control management
  4. Records retention and management
  5. Record storage
- E. Feasibility studies and office work measurement
  1. The preliminary study
  2. Feasibility study
     a. Study committee
     b. Study plan
     c. Equipment recommendations
     d. Equipment evaluation
     e. Final report
  3. Work measurement techniques
     a. Predetermined time-standard studies
     b. Timing device studies
     c. Micromotion studies
     d. Work sampling studies
     e. Time record studies
     f. Historical studies
  4. Work measurement for data processing equipment
     a. Key-driven equipment studies
     b. Rated machine speed studies

II. Data Processing Equipment
- A. Introduction to unit record equipment
  1. The punched card
  2. Card punch machines
- B. Card sorters, collators, and interpreters
- C. Unit record accounting machines and calculators
  1. Accounting machines
     a. Machine type and rates of speed
     b. Printing principles and features
     c. Accumulating principles and features
     d. Multi-line printing
  2. Calculating punches
- D. Basic accounting equipment and procedures
  1. Pegboard payroll application
  2. Key sort method

III. Techniques for Systems and Data Processing Applications
- A. Charting
  1. Symbols for paper work flow
  2. Creating process charts and flow charts
- B. Methods of coding and condensing data

1. Block code
2. Group classification code
3. Significant digit code
4. Final digit code
5. Complete sequence code
6. Phonetic index code

C. Card design
1. Analysis of work sheet
2. Transcript card
3. Dual card
4. Mark sense card
5. Summary card

D. Forms design
1. Designing forms for machine processing
2. Basic factors of forms design

IV. Business Procedures and Procedure Applications

A. Purchasing and receiving
1. Purchase requisition
2. Request for quotation
3. Purchase order
4. Receiving report
5. Adjustments

B. Materials control
1. Materials control form
2. Control record of perpetual inventory

C. Production control
1. Routing function
2. Scheduling function
3. Dispatching function

D. Product distribution and billing

E. Accounts receivable and collections

F. Disbursements and distribution
1. Establishing and validating invoices
2. Posting liabilities
3. Payment of invoices
4. Payroll disbursements

Texts and References

LAZZARO. *Systems and Procedures.*
RANDALL AND BURGLY. *Systems and Procedures for Business Data Processing.*

PROGRAMMING PROJECTS

Periods Per Week: 5

Class, 1; laboratory, 4

Description

This project course is designed for students who are preparing for a career in programming. They may choose to acquire the work experience the course provides as an alternative to enrollment in *Computer Operations* if the facility is not available.

Hours scheduled for class, laboratory, outside work and study are flexible. Hours set out in this curriculum outline are considered minimal. Students actually may devote as many as 80 hours to a project, but this figure is considered to be the maximum. Although formal classes are not required, instructors should schedule at least one period at the beginning of the semester for the purpose of orienting enrolled students. They should be informed in detail concerning the content of the course and the mode in which the program will be conducted. Directed seminars in which students exchange views on the status and progress of ongoing projects may be scheduled as deemed useful.

Instructors will assign work projects to individual students. The work requirement is actual; the problem presented is not formulated nor synthesized. Tasks are selected from those actually developed within the school, such as programming student records, business accounts, class schedules, and other similar data processing operations. Projects also can be provided by local businesses and industries; for example, programming payrolls, personnel records, production schedules, stock records, and customer accounts.

When a project is assigned to a student, the instructor in effect assumes the role of a data processing supervisor, typifying a counterpart with whom students can expect to work in a future job. In the same pattern, students are required to provide status reports, notification of problems encountered, and their plans for problem solutions. It likewise is demanded of them that the completion dates of work phases be met as scheduled.

It is essential that instructors possess the technical knowledge and experience requisite to exercising effective supervision over each student's work performance. In this respect, it virtually is mandatory that the instructor's background include responsible data processing experience in business or industry.

Upon completion of their work projects, students will have had actual experience in systems analysis and design, program specification, programming in several computer languages, in program testing and debugging, and in program documentation.

Texts and References

Texts and references include all those used previously in the curriculum. In addition, extensive use is made of manufacturers' publications dealing with computer hardware and applications.

PUNCHED CARD DATA PROCESSING I

Periods Per Week: 5

Class, 3; laboratory, 2

Description

This course is an introduction to the background and functions of the punch card equipment that comprises the base element of mechanized accounting systems. Laboratory practice problems provide experience in the operation of the sorter, collator, interpreter, reproducing punch, and tabulating machines.

Major Divisions

		Hours	
		Class	Laboratory
I.	Background of Punched Card Data Processing	5	0
II.	Principles of Punched Card Data Processing	10	4
III.	The Recording Function	12	10
IV.	Machine Functions	15	15
V.	Controls	6	3
	Total	48	32

I. Background of Punched Card Data Processing
- A. Early uses of punched card equipment
- B. Development of equipment companies
  1. IBM Corporation
  2. Development of machinery
- C. The need for punched card data processing
  1. Clerical worker shortage
  2. Increasing volume of data
  3. Expanded emphasis on accuracy and control, economy, and better report schedules

II. Principles of Punched Card Data Processing
- A. Units of instruction
  1. Problems in processing source documents
  2. Introduction to machine languages
     a. Types of punched cards
        (1) Eighty-column cards
        (2) Ninety-six-column cards
     b. Coding systems
  3. Assignment of fields
- B. Laboratory
  Solve practice problems in coding information and assigning fields.

III. The Recording Function
- A. Units of instruction
  1. Card punching
     a. Entry of data on card
     b. Duplicating function
  2. Verifying
  3. Reproducing punch
     a. Reproduction of one field only
     b. Reproduction of "80-80"
     c. Gang punching
     d. Interspersed gang punching
     e. Digit emitter
     f. Mark-sensed punching
  4. Interpreting
  5. Transfer posting
  6. Optical scanning
- B. Laboratory
  Solve practice problems that provide experience in the operation of the reproducing punch, verifier, and interpreter.

IV. Machine Functions
- A. Units of instruction
  1. Classifying function
     a. Sorter
     b. Collator
        (1) Merging
        (2) Matching
        (3) Selecting
  2. Calculating function
     a. Reduction to mathematical formula
        (1) Multiplication of data
        (2) Division of data
        (3) Addition of data
        (4) Subtraction of data
     b. Group multiplication
  3. Summarizing function
     a. Tabulator
        (1) Tabbing and listing
        (2) Classes of totals
     b. Automatic carriage
     c. Summary punching
- B. Laboratory
  Solve practice problems involving the use of the sorter, collator, tabulator, and calculator.

V. Controls
- A. Units of instruction
  1. Balancing
  2. "Hash totals"
  3. Applications
     a. Payroll master file
     b. Inventory control

B. Laboratory

Using the two applications described in the classroom, practice establishing a payroll master file, processing a payroll, or controlling an inventory.

Text

VAN NESS. *Principles of Punched Card Data Processing.*

PUNCHED CARD DATA PROCESSING II

Periods Per Week: 5

Class, 3; laboratory, 2

Description

This course builds on the material presented in *Punched Card Data Processing I* and continues through coding systems, the binary mode, standard data processing practices, and elementary wiring concepts.

Major Divisions

		Hours	
		Class	*Laboratory*
I.	Coding Systems	12	12
II.	Data Processing Practices	12	12
III.	Responsibilities of Data Processing Department	12	0
IV.	Technological Advances	12	8
	Total	48	32

I. Coding Systems
- A. Units of instruction
  1. Automatic application of codes
     a. Master code cards
     b. Prepunched code cards
     c. Automatic decoding
     d. Line selection device
  2. Sequence codes
  3. Block codes
  4. Group classification codes
  5. Significant digit codes
  6. Final digit codes
  7. Decimal codes
  8. Mnemonic symbols
  9. Numerical-alphabetical codes
  10. Consonant codes
  11. Phonetic index codes
- B. Laboratory
  Solve practice problems in specific methods of coding data.

II. Data Processing Practices
- A. Units of instruction
  1. Size of department
     a. Points
     b. Number of tabulators
  2. Shifts
  3. Machine capacities
  4. Control panels and wires
     a. Control panel
     b. Fixed and temporary wires
     c. Length of wires
     d. Split wires
  5. Cards and forms
     a. Stock and special cards
     b. Common stock forms
- B. Laboratory
  Solve practice problems in the elementary wiring of a control panel.

III. Responsibilities of Data Processing Department
- A. Control of requests for service
- B. System of identifying reports
- C. Scheduling system
  1. Distribution control sheet
  2. Schedule book
- D. Procedures and controls
  1. Outlined or detailed procedures
  2. Constantly updated
  3. Procedure control sheet
- E. Time utilization
  1. Machine time and personnel hours
  2. DPMA
  3. Report numbering system
- F. Control over report distribution

IV. Technological Advances
- A. Units of instruction
  1. Types of data processing systems
     a. Input and output devices
     b. Storage
     c. Central processing unit
  2. Stored programs
  3. Binary mode
  4. Computer codes
     a. Code checking
     b. Seven-bit alphameric code
     c. Two-out-of-five fixed-count code
     d. Bi-quinary code
     e. Six-bit numeric code
  5. Data recording media
     a. Punched cards
        (1) Punched card code
        (2) Row binary data representation
        (3) Column binary data representation
     b. Paper tape
        (1) Eight-channel code
        (2) Five-channel code
     c. Magnetic tape
- B. Laboratory
  Solve practice problems in binary numbers.

Text

VAN NESS. *Principles of Punched Card Data Processing.*

LIBRARY SUPPORT FOR THE SUGGESTED CURRICULUM

In the past decade, libraries have undergone accelerating change from the traditional book-lending institutions into centers providing all types of resources and services to meet instructional and individual needs. This concept of integrating various print and nonprint materials into a single administrative unit to provide learning resources, regardless of format, has been incorporated into this curriculum outline.

As described by the American Library Association,[2] such a library-media center would provide the following materials and services:

1. Materials for class instruction and individual investigation and exploration.
2. Instruction to improve learning through the use of printed and audiovisual resources.
3. Information on new educational developments.
4. New materials created and produced to suit special needs of students and teachers.
5. Consultant services to improve learning, instruction, and the use of library-media center resources.
6. Working areas that are planned to facilitate efficient operation by the center staff and efficient use by students and faculty.

In short, a library-media center should be designed both as a resource for learning and a resource for teaching readily accessible to all those involved in the education process.

Library Staff and Budget

The American Library Association (ALA) and the National Education Association (NEA), in their standards and guidelines for high schools,[3] strongly recommend a unified media program, integrating the resources of the school library and the audiovisual aids department into one administrative unit. In addition, they suggest that the head media librarian report to the principal or other chief school officer, and that the library-media center maintain one full-time professional for every 250 students. To minimize the likelihood that the professional staff would be involved in the performance of clerical, housekeeping, and technical tasks, an adequate supportive staff must also be maintained: at least one media technician and one media aide for each professional library media specialist in schools of 2,000 or fewer students.

When a program is initiated, a substantial supporting investment in library-media materials is essential. This should be incremented annually by funds to be used for updating books and other media on hand and for securing necessary new material. Items suggested for consideration include but are not limited to the following:

- Books
- Magazines
- Newspapers
- Pamphlets, clippings, and miscellaneous materials
- Filmstrips
- 8mm Films[4]
- 16mm Films
- Transparencies
- Tape and disk recordings
- Graphic materials such as art prints, photographs, posters, charts, diagrams, and graphs
- World globes
- Maps
- Microfilm
- Microfiche
- Programmed instructional materials

Suggested Technical References

The following is a typical list of journals, periodicals, and technical magazines which would be desirable in the library-media center of a school offering course work in data processing.[5]

AEDS MONITOR: Association for Educational Data Systems, 1201 Sixteenth St., N.W., Washington, D.C. 20036

AUTOMATION: The Penton Publishing Company, Penton Building, Cleveland, Ohio 44113

AUTOMATION AND REMOTE CONTROL: Instrument Society of America, 530 William Penn Place, Pittsburgh, Pa. 15219

COMMUNICATIONS OF THE ACM: Association for Computing Machinery, 211 E. 43rd St., New York, N.Y. 10017

COMPUTERS AND AUTOMATION: Berkeley Enterprises, Inc., 815 Washington St., Newtonville, Mass. 02160

[2] American Library Association and the National Education Association, *Standards for School Media Programs*, 1969, p. 4.

[3] American Library Association and the National Education Association, *Standards for School Media Programs*, 1969.

[4] A list of film distributors is provided in appendix B.

[5] A list of supplementary references for use in secondary school instruction is given in appendix C.

COMPUTER CHARACTERISTICS QUARTERLY: Adams Associates, Inc., 575 Technology Square, Cambridge, Mass. 02139

COMPUTER DIGEST: American Data Processing, Inc., 4th Floor, Book Building, Detroit, Mich. 48226

COMPUTER AND THE HUMANITIES (NEWSLETTER): Queens College of the City University of New York, Flushing, N.Y. 11367.

COMPUTER NEWS: Technical Information Company, Martins Bank Chambers, P. O. Box 59, St. Helier Jersey, British Channel Islands.

COMPUTER JOURNAL: The British Computer Society, Finsbury Court, Finsbury Pavement, London, E.C. 2

COMPUTING REPORT FOR THE SCIENTIST AND ENGINEER: Data Processing Division, International Business Machines Corporation, White Plains, N.Y. 10601

COMPUTING REVIEWS: Association for Computing Machinery, 211 E. 43rd St., New York, N.Y. 10017

DATAMATION: F. D. Thompson Publications, Inc., 205 W. Wacker Dr., Chicago, Ill. 60606

DATA PROCESSING DIGEST: Data Processing Digest, Inc., 1140 South Robertson Blvd., Los Angeles, Calif. 90035

DATA PROCESSING FOR EDUCATION: American Data Processing, Inc., 4th Floor, Book Building, Detroit, Mich. 48226

DATA PROCESSING MAGAZINE: Data Processing Magazine, 134 North 13th St., Philadelphia, Pa. 19107

D.P.M.A. QUARTERLY: Data Processing Management Association, 505 Busse Highway, Park Ridge, Ill. 60068

INFORMATION RETRIEVAL LETTER: American Data Processing, Inc., 4th Floor, Book Building, Detroit, Mich. 48226

MODERN DATA: Modern Data Services, Inc., 3 Lockland Ave., Framingham, Mass. 01701

LABORATORY FACILITIES, EQUIPMENT, AND COSTS

A high school electing to implement only a minimal literacy experience for its students need not invest in computer equipment if to do so would impose an unbearable financial burden. A course such as *Introduction to Computers* can be taught effectively without the use of terminals or related hardware, if supplemental experiences are carefully selected. Such experiences might include extended visits to local computer companies or users to acquaint students with some of the capabilities and applications of various machinery.

High schools or secondary school districts electing to offer the expanded literacy program or the total curriculum will need to make provisions for laboratory equipment and computer facilities for their students. Student access to appropriate equipment is essential for achieving the curriculum objectives. System configurations which will meet the minimum requirements for such a program can vary greatly according to the size and type of the program to be offered. The following three approaches to providing suitable laboratory experience are representative of current practice and illustrate dramatically the broad range of alternatives for resource allocations at most institutions. These approaches, listed by cost in ascending order, are:

- Transport students to a computer facility located within reasonable distance.
- Install on-campus, remote terminal units connected with a central computer facility.
- Develop a complete on-campus data processing laboratory facility.

Selection of the approach to be used in providing essential equipment for student use represents the development and acceptance of critical decisions. They are critical in the sense that error can result in catastrophic financial loss as well as in an equipment array that is unsuited to its educational purpose. For this reason, decisions in this area should be accepted and implemented only on the basis of exhaustive study representing maximum use of every available competent resource. Resource persons include educational consultants, employers of data processing personnel, faculty members, and representatives of equipment manufacturers. The contributions from such resource persons can be coordinated and evaluated by the program advisory committee. Only by maximum use of competent resource persons can the committee be assured of obtaining the right facilities at the right cost.

Transporting Students to Computer Facilities

High schools frequently have used the computer facilities at other educational institutions, governmental agencies, or commercial organizations by physically transporting the data and/or users to and from the computer site. While this arrangement can hardly be described as optimal, it does enable a high school to provide programming instruction to its students in all the languages currently available on the computer system. Frequently, high schools wishing to provide such instruction can purchase time on the computer facility used by the local board of education for administrative purposes. Arrangements can also be made for instruction in computer operations with students assigned as apprentices to site operators. While scheduling and transporting students results usually in at least occasional inconvenience, much can be gained in local support, student motivation, and graduate placement by linking the programming curriculum closely to area business and industry.

Terminals Only

The basic requirement for a terminal installation is to provide access to a time-sharing system capable of supporting whatever language is being taught. To support advanced language courses, the central system must be able also to handle current versions of the compiler.

There are two basic types of terminals having minimal space requirements, no special power demands, and requiring no structural modifications prior to installation: the CRT and the hard-copy device. Input to the central computer is accomplished from both units through a keyboard; output is registered as a CRT display or as a hard-copy printout. It is suggested that terminals be installed in a separate room to prevent interference with classes. In addition to a terminal room and classroom space, facilities should include a programming workroom with storage lockers for the use of programming students. The workroom should also contain large programming tables which measure at least 4 by 5 feet and can

accommodate two students simultaneously.

Fifteen to 20 full-time majors are the optimal number of students served by one terminal. Intensive scheduling over each 24-hour period can, however, accommodate more students per terminal and thus reduce the total number of units installed. Enrollment in introductory courses should not exceed more than 50 students per class section, unless there are several good laboratory instructors assigned to the class. Students can be divided into groups of 20-25 provided laboratory instructors are available to answer questions and provide assistance.

The major instructional limitation on a terminal installation is that a course in computer operations cannot be offered. Such a course necessitates extensive "hands-on" experience that cannot be provided without a computer facility at the school. Moreover, a particular time-sharing system may be subject to overload, thus reducing the efficiency of instruction.

A major advantage of a terminal installation for high school use is that arrangements frequently can be made to link the terminals to the computer leased for administrative purposes at the school system's headquarters. Not only does this provide highly sophisticated computer capabilities for the programming students, it also encourages the 24-hour per day use of costly board of education equipment.

On-Campus Computer Facilities

If the use of terminals is deemed unacceptable either because of the instructional or enrollment limitations which it imposes on the curriculum, a computer facility can be installed on the campus. The amount and level of sophistication of the equipment selected naturally will be related closely to the depth and scope of the courses to be offered and the number of students to be served. If students are expected to master several programming languages, for example, the facility must have the capability of processing such input.

In establishing any computer facility, sound preliminary planning is essential to completing at minimum cost an installation that will serve the intended purpose and lend itself to possible future expansion.

Building Requirements

Once the decision has been made to install a computer laboratory, a complete list of components to be used in the system should be prepared. This list will include the data processing equipment, furniture, tape storage cabinets, work tables, chairs, and desks. At the same time, a suitable location for the laboratory area must be chosen. Modification of existing space may provide a suitable location, or, in some instances, a complete new building may be necessary. The following are important considerations in selecting a location for the computer installation:

- Availability of adequate power (including standby power)
- Space to house air conditioning equipment
- Ceiling height, outside wall and glass area, and other factors related to air conditioning and maintaining the required humidity in the computer facility
- Traffic flow to and from other areas
- Floor loading capacity
- Adequate safety and fire prevention procedures

Space and Layout

Space and layout requirements hinge on the physical area available and the dimensions of the specific components to be installed. Floor area will be determined by the length-to-width ratio of rooms, location and dimensions of columns and walls, and consideration for future expansion. The exact area required for hardware and furnishings can be determined from a scale layout, using room measurements and cardboard cutouts representing the floor dimensions of each item to be emplaced.

Space should be provided within the computer room for the daily storage of tape, cards, and printed forms. Permanent master documents, punched card records, magnetic tape, and other combustible materials should be stored in properly designed and protected storage areas. Ideally, storage areas should be located so that both the amount of space required and travel time between areas is minimized. Space also must be planned for storage cabinets, card and record files, printer forms, work tables, desks, and communications facilities.

In addition, the equipment manufacturer may assign test equipment to the installation to maintain the equipment in the machine room. Space will need to be allocated for this purpose, although some machines may be moved to the test area, depending on the type of work to be done. Whenever possible, test areas should be on the same floor level; if they are not, ramps must be provided for moving test equipment and machine components. Detailed space requirements and specifications for the test area can be obtained by consulting with the system manufacturer's field engineers.

Floor Construction

A structural engineer should be consulted to determine whether the floor of the proposed facility is capable of supporting the system weight load. A raised or false floor can be constructed of steel, aluminum, or fire-resistant wood and will accomplish the following major objectives for building design:

- Allow for future layout change with minimum reconstruction cost.
- Protect interconnecting cables and power receptacles.
- Provide for personnel safety.
- Permit the space between the two floors to be used to supply air for the air-conditioning system.

The two general floor types are illustrated in figure 2. The free-access floor is preferred over the raceway type; a raised-floor panel lifter should be made readily available at a convenient location in the computer room.

Floor covering material can contribute to the building of high static electrical charges resulting from the movement of people and equipment in contact with the floor material. The abrupt discharge of this static electricity can cause discomfort to personnel and may result in the malfunction of electronic equipment. The buildup and discharge of static electricity can be minimized by providing a conductive path to ground from a metallic raised floor structure, and ensuring that maximum resistance for floor tile or other floor surface material is 2×10^{10} ohms, measured between floor surface and building.[6] Carpet floor covering should be of the "antistatic" type, either having antistatic properties manufactured into the material or being of a kind that can be treated effectively with antistatic agents.

Vacuuming equipment used in the machine area should have a non-conductive hose and nozzle assembly. This safety precaution minimizes the possibility of static discharge or electrical shock.

Acoustics and Lighting

The principal sources of noise in a computer facility are the mechanical units such as card punch machines, printers, readers, sorters, and blowers. The walls and floor should be constructed to prevent the transmission of noise and vibration to adjacent areas. Walls and doors must be solidly constructed and have a good seal. The greatest sound reduction will be obtained by installing a dropped porous ceiling. Precautions also must be taken to prevent the noise generated in the machine room from being transmitted through overhead ducts to other rooms. Floor and wall surfaces should be covered with absorptive materials to prevent reverberations.

The machine room area should be lighted with a minimum average illumination of 40 foot-candles, measured 30 inches above the floor. Direct sunlight should be avoided because various console and signal lamps can be observed best under lower levels of illumination. Direct sunlight may also cause malfunctioning of devices that employ light sensing (such as certain magnetic tape units). Lights for general illumination should be controlled sectionally so that they can be used in areas where needed and turned off where not required. Lights should not be powered from the computer power panel.

Air-Conditioning

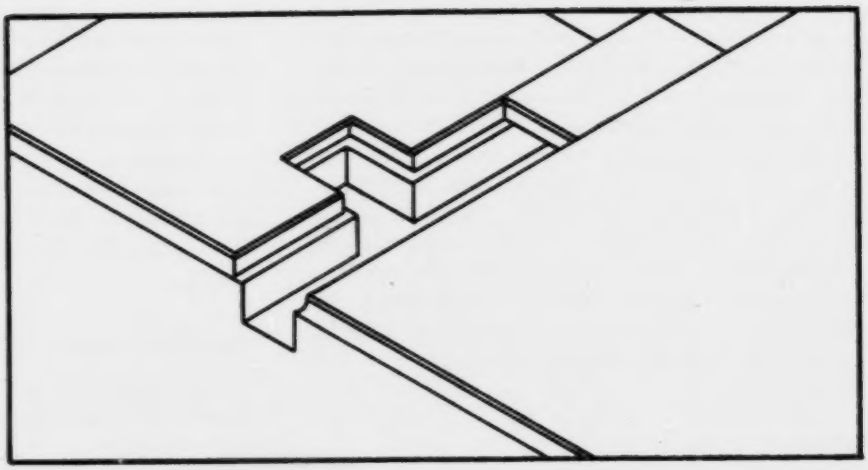
Computer components are air-cooled internally by the use of built-in blowers. Air intake generally is through the bottom of the unit and through louvers along its bottom edges. Warm air usually exhausts from the top of each unit.

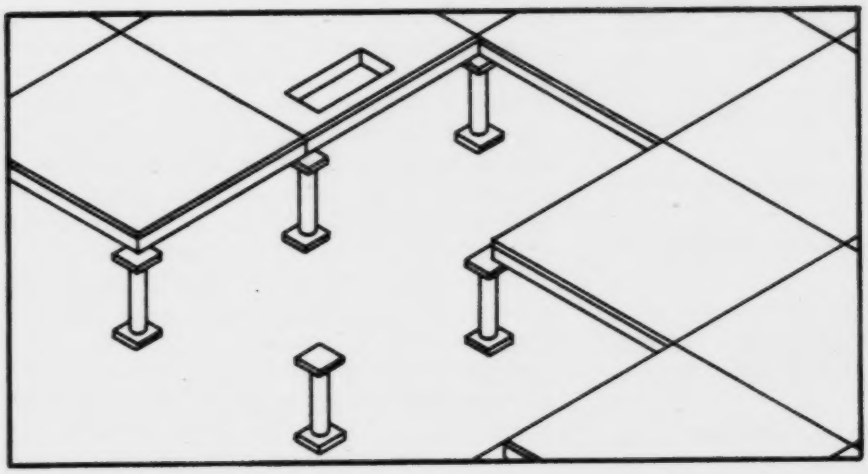
The following factors must be considered in determining the air-conditioning capacity necessary for an installation:

- Machine heat dissipation
- Number of personnel

[6]The procedure outlined in the *National Fire Protection Association Standard No. 56*, chapter 25, section 2522, should be used.

Raceway floor:
Removable covers
with cutouts





Free access floor:
Pedestal supported,
removable panels with
cutouts

Free access floor:
Subframe supported,
removable panels
with cutouts

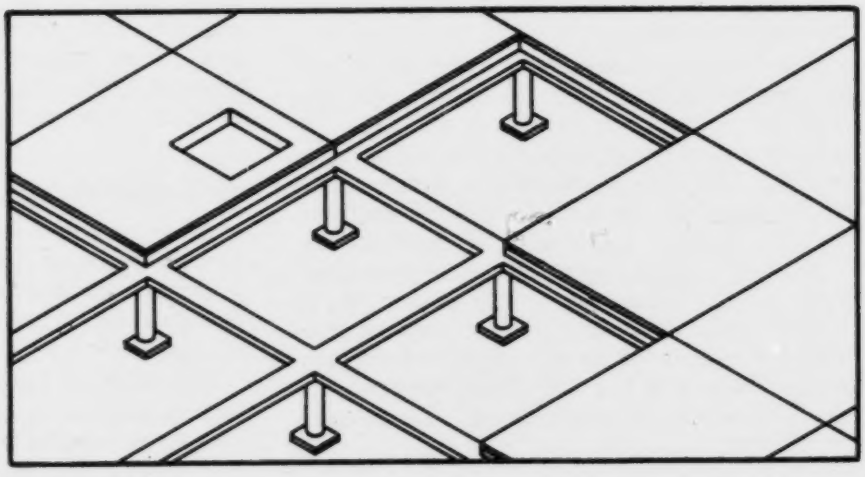


Figure 2. — Types of raised flooring

- Latent load
- Fresh air introduction
- Heat infiltration through outer walls
- Ceiling
- Floors
- Door openings
- Partitions
- Glass wall areas
- Possible reheat

A dedicated air-conditioning system, separate from any other system, is recommended for a computer facility; it is necessary that the system maintain a cooling cycle year-round. The air-conditioning should be designed to operate at 75 degrees Fahrenheit and 50 percent humidity at altitudes up to 7,000 feet. This provides the largest time buffer for the computer system if the air-conditioner fails or malfunctions. The computer can be operated until it reaches its specified limits and the possibility is increased that repairs can be effected before the computer must be shut down. The same design standard provides a generally acceptable level of comfort for personnel.

The heat load of the computer system is concentrated in a relatively small area. For this reason, attention should be given to the method of air distribution to eliminate areas of excess air motion.

The air-conditioning system should use predominantly recirculated air with a set minimum for introduction of fresh air for personnel. This minimum fresh air input will allow the machine area to be pressurized so that air leakage is always outward, thus minimizing dust entry from adjacent areas.

Several types of air-conditioing systems can be designed to satisfy the temperature and humidity requirements, including:

- Single duct (overhead system)
- Two duct (two air conditioning units)
- Two duct (single air conditioning unit)
- Underfloor system

It is recommended that an experienced air-conditioning design engineer consider each of these methods of air distribution and check all local building codes. The electrical code should also be examined, since some localities do not permit the use of the raised floor for air-conditioning.

Safety and Fire Precautions

Safety considerations are important factors influencing the choice of computer location, building materials, an air-conditioning and electrical system, and fire prevention equipment.[7]

The computer should be in a non-combustible or fire-resistant building or room and should not be adjacent to areas where inflammable or explosive materials or gases are located. Walls should be of non-combustible materials and should extend from floor to ceiling.

If a computer area has one or more outside walls adjacent to a building that is susceptible to fire:

- Installation of shatterproof windows in the computer room would serve to protect personnel and equipment from flying debris and water damage.
- Sprinklers could be installed externally over windows to protect them with a stream of water in case of fire in an adjacent area.
- Windows could be sealed with masonry.

Where a hung ceiling and raised floor are used, they should be constructed of noncombustible material; all ducts and insulating should likewise be fire-resistant and nondusting. The roof or floor above the computer and tape storage areas should be a watertight slab. If possible, the walls of the room should be sealed to the slab in a way to prevent water from entering overhead.

Any data stored in the computer room, whether in the form of magnetic tape, paper tape, cards, or paper forms, should be enclosed in metal cabinets or fire-resistant containers and limited to the minimum needed for safe, efficient operation.

After having consulted with the appropriate architectural and electrical engineers and representatives of equipment manufacturers, a school or school district should be ready to design and equip an actual computer facility. The amount and level of sophistication of the equipment to be selected will hinge primarily on the number of students and staff members to be involved in its operation and on the goals of the program. It is anticipated that a high school initiating a computer science and data processing curriculum might do so in phases because of budgetary con-

[7]For additional reference material, consult NFPA Standard No. 75, "Protection of Electronic Computer/Data Processing Equipment."

siderations and because of the need to proceed one step at a time in a new curriculum area. A graduated development of a total capability in the computer area is a realistic and generally preferable goal for most school districts.

The following discussion of laboratory facilities has been developed for a program involving 30-35 beginning students, 20 advanced students, and four instructors in the technical specialty courses. Students in excess of this number could be accommodated by providing multiple laboratory sections.

Figures 3 and 4 represent examples of floor plans. It must be recognized that the development of computer facilities is highly dependent upon the types and quantities of equipment selected. In many cases, the location of specific equipment will limit or dictate the location of other equipment. For example, the selection of a location for the central processing unit (CPU) dictates, to a large extent, the location of input-output devices, tape units, secondary storage units, and other devices with which it is physically connected. Doorways should be located for easy traffic flow into and out of the laboratory. In addition, storage areas should be located so that the instructor readily can control the security of key programs and software. Consideration also must be given to the storage of diagnostic programs and maintenance equipment belonging to equipment vendors. Again, the amount of space required is dependent upon the equipment selected and should be determined during the period of equipment negotiations with the vendor.

The sample layout includes a student programming room consisting of individual programming carrels. While the carrels are not mandatory, the advantage of this arrangement is evident when consideration is given to the degree of concentration required for program writing and the characteristics of individualism and creativity that are represented in each meaningful program.

Equipment Costs

The cost of equipment is a prime consideration when planning an education program. Equipment can be rented or leased, or new or used equipment can be purchased. Reaching a decision on which course to follow is complicated by the availability of options with each piece of equipment and the necessity for a maintenance contract. In addition, equipment vendors have developed a policy of offering an education discount ranging from 10 to 60 percent. Whether equipment is purchased or leased, a monthly maintenance fee, varying in amount with specific equipment and options, must be negotiated with prospective vendors.

Approximate costs of computer equipment are listed in tables 1 and 2. The figures stated represent the cost of the equipment installed by the vendor, but they do not include the cost of the building, special flooring, air-conditioning, or other such items. However, the amounts listed can be considered as generally typical of the level of funds necessary to obtain various items of equipment for an educational data processing center.

The largest single item of equipment cost is the CPU. Educational institutions, planning a computer facility for instructional purposes only, seldom will find it necessary to obtain a CPU larger than medium size. An exception may occur if local businesses, industrial concerns, government agencies, or other schools arrange to share, and thus pay for, the added productive capacity of a large unit.

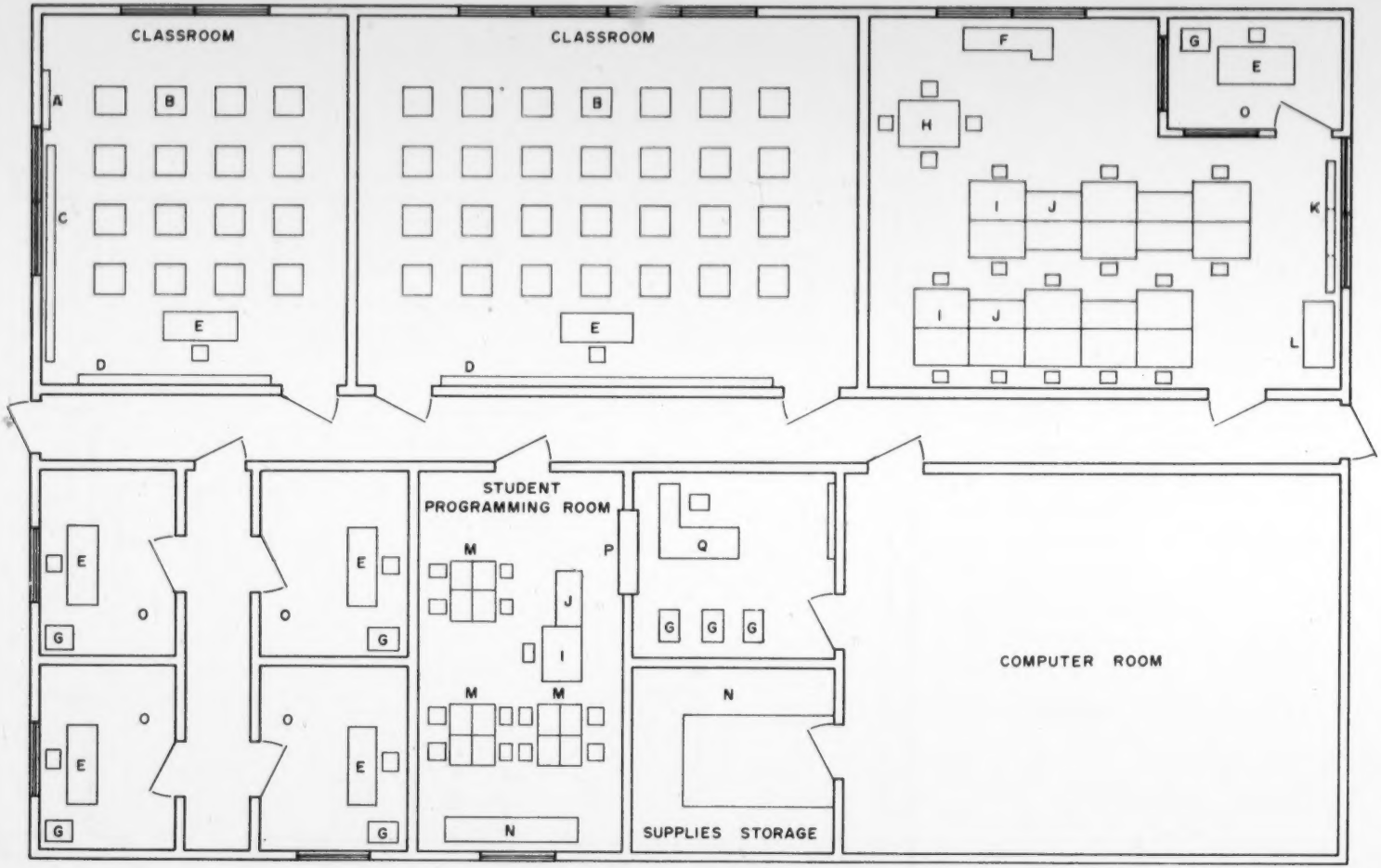
Table 1. — Estimated Purchase Costs and Monthly Rental on Computer Equipment

Description	Estimated Costs	Rental Per Month
Central Processing Unit	$75,000 to $120,000	$1,400 to $2,000
Card I/O unit	25,000 to 35,000	500 to 600
Secondary storage units (2)	35,000 to 45,000	1,000 to 1,500
Printer	25,000 to 35,000	300 to 450
Keypunch machines (each)	1,000 to 1,200	60 to 75
Sorter	2,500 to 3,000	40 to 50
Card verifier	2,500 to 3,000	40 to 50
Interpreter	5,000 to 6,000	100 to 150
Card Files	50 to 75	
Sorting rack	50 to 75	

Table 2. — Computer System Classification by Size and Cost[a]

Computer Size	Monthly Rental
Mini	under $1,200
Small	$1,200 to $5,000
Medium	$5,000 to $40,000
Large	$30,000 to $150,000

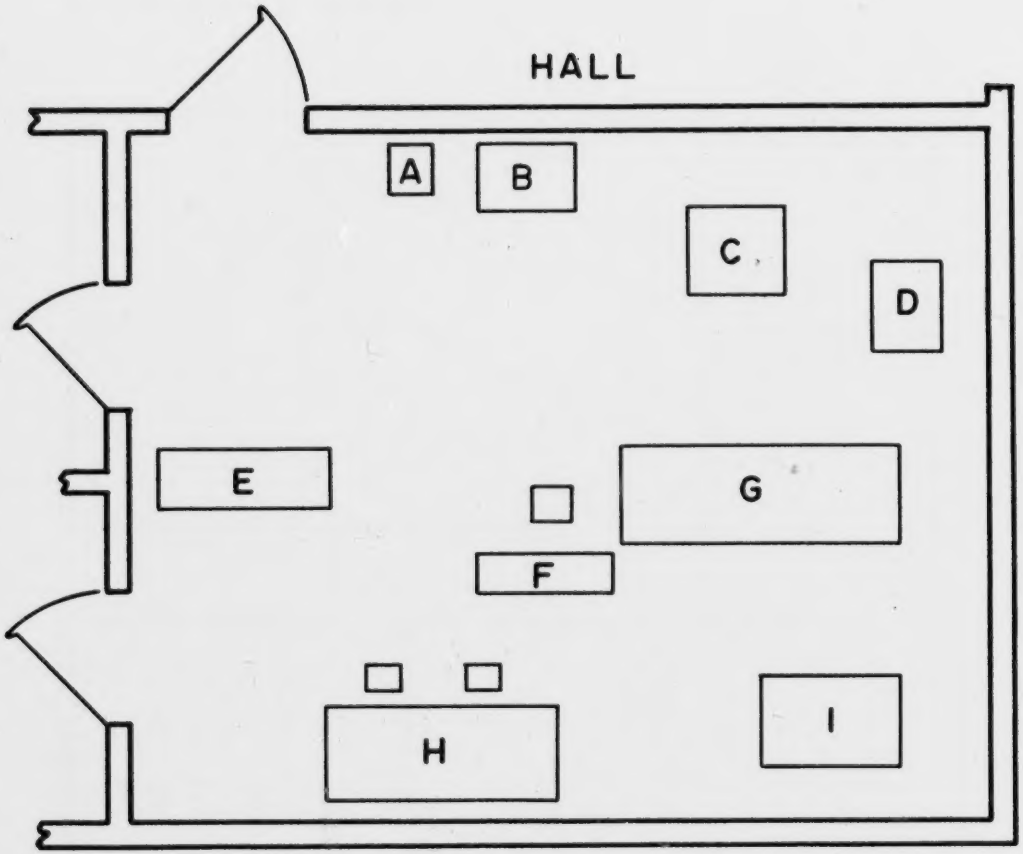
[a]The cost of equipment is related directly to the size and capability of the system desired by the institution.



LEGEND

A. Bulletin Board	D. Chalk Board	G. File Cabinet	J. Verifier	M. Programming Carrels	P. Window Counter
B. Student Desk	E. Instructor's Desk	H. Work Table	K. Card Racks	N. Storage Shelves	Q. Manager's Desk
C. Bookcase	F. Sorter	I. Keypunch	L. Interpreter	O. Instructor's Office	

Figure 3. — Computer center layout



LEGEND

A. Card file
B. Keypunch
C. Magnetic tape unit
D. Disk storage
E. Card I/O unit
F. I/O terminal
G. Central processing unit
H. Programming table
I. Printer

Figure 4. — High school computer room

The mini or small computer probably is most widely used in school computer facilities. By their use, high schools are provided with computing capability with "their own" computer. The total annual operating costs for systems in this class range from $10,000 to $60,000. The hardware varies from an 8-kilobit system with teletype input/output plus one symbolic and one compiler language upwards to a 16-kilobit unit with disk and tape, card reader and punch, line printer, and multiple language capability. The smaller of these systems are the "batch" type while the larger systems are capable of time-sharing operations.

All of the foregoing factors should be considered in close cooperation with the advisory committee to decide the course of action to implement, the equipment to select, and the price to pay.

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APPENDIXES

Appendix A

List of Resource High Schools and Public School Systems

The high schools, school systems, and educational agencies listed below have participated in various ways in the development of this suggested curriculum. Those marked by an asterisk were visited by project staff members who observed data processing education programs in progress and were provided invaluable data by program administrators and teachers. Other institutions listed were most helpful in providing information in response to numerous requests.

Atlanta Public Schools
Atlanta, Ga.

*Cass Technical High School
Detroit, Mich.

*Dade County Public Schools
Miami, Fla.

*Denver Public Schools
Denver, Colo.

Education Service Center, Region IV
Houston, Tex.

*Einstein High School
Kensington, Md.

*Lane Technical High School
Chicago, Ill.

Los Angeles Unified School District
Los Angeles, Calif.

*Northwestern Educational Development Laboratory
Portland, Ore.

Oklahoma Public School System
Oklahoma City, Okla.

Project LOCAL
Westwood, Mass.

Ridgewood High School
Ridgewood, N.J.

*School District of Philadelphia
Philadelphia, Pa.

*Skyline High School
Dallas, Tex.

*The Board of Public Education
Pittsburgh, Pa.

Appendix B

Curriculum Adapted To A 1-Year Program

COMPUTER PROGRAMMING (OBJECTIVE: PROBLEM-SOLVING TOOL)

This course is a three-period instructional program to be completed in one academic year. Students are given hands-on experience in computer operations if appropriate equipment is available.

	Periods Per Week		
	Class	*Lab*	*Total*
Grade 9, First Semester			
English	5	0	5
Mathematics	5	0	5
Science	4	1	5
History	5	0	5
Elective*	—	—	5
Total			25
Grade 10, First Semester			
English	5	0	5
Mathematics	5	0	5
Science	4	1	5
Elective*	—	—	5
Elective*	—	—	5
Total			25
Grade 11, First Semester			
English	5	0	5
Mathematics	5	0	5
History	5	0	5
Elective*	—	—	5
Elective*	—	—	5
Total			25
Grade 12, First Semester			
English	5	0	5
Civics	5	0	5
Procedures for Organizing Information**	5	0	5
Introduction to COBOL	3	2	5
FORTRAN Applications Programming**	3	2	5
Total	21	4	25

	Periods Per Week		
	Class	*Lab*	*Total*
Grade 9, Second Semester			
English	5	0	5
Mathematics	5	0	5
Science	4	1	5
History	5	0	5
Introduction to Computers**	3	0	3
Total	22	1	23
Grade 10, Second Semester			
English	5	0	5
Mathematics	5	0	5
Science	4	1	5
Introduction to Programming**	3	2	5
Elective*	—	—	5
Total			25
Grade 11, Second Semester			
English	5	0	5
Mathematics	5	0	5
History	5	0	5
Elective*	—	—	5
Elective*	—	—	5
Total			25
Grade 12, Second Semester			
English	5	0	5
Economics	5	0	5
Advanced COBOL Programming**	3	2	5
Rrogramming Projects** (or Computer Operations**)	1/3	4/2	5
Business Applications Development**	2	3	5
Total	18/16	7/9	25

*Suggested electives might include Language, Typewriting, Accounting, or other courses to meet the student's individual program objectives.

**Course description and outline provided in previous section.

EDP PERIPHERAL EQUIPMENT OPERATION (OBJECTIVE: JOB ENTRY)

This course is a three-period instructional program designed to be completed in one academic year. Students are trained to operate office machinery and to keypunch data for computer use. In addition, they are given hands-on experience in computer operations if appropriate equipment is available.

	Periods Per Week		
	Class	*Lab*	*Total*
Grade 9, First Semester			
English	5	0	5
Mathematics	5	0	5
Science	4	1	5
History	5	0	5
Elective*	—	—	5
Total			25
Grade 10, First Semester			
English	5	0	5
Mathematics	5	0	5
Science	4	1	5
Elective*	—	—	5
Elective*	—	—	5
Total			25
Grade 11, First Semester			
English	5	0	5
Mathematics	5	0	5
History	5	0	5
Accounting	5	0	5
Elective*	—	—	5
Total			25
Grade 12, First Semester			
English	5	0	5
Civics	5	0	5
Office Machines**	3	2	5
Punched Card Data Processing I**	3	2	5
Beginning Keypunch**	1	4	5
Total	17	8	25

	Periods Per Week		
	Class	*Lab*	*Total*
Grade 9, Second Semester			
English	5	0	5
Mathematics	5	0	5
Science	4	1	5
History	5	0	5
Introduction to Computers**	3	0	3
Total	22	1	23
Grade 10, Second Semester			
English	5	0	5
Mathematics	5	0	5
Science	4	1	5
Introduction to Programming**	3	2	5
Elective*	—	—	5
Total			25
Grade 11, Second Semester			
English	5	0	5
Mathematics†	5	0	5
History	5	0	5
Economics	—	—	5
Elective*	—	—	5
Total			25
Grade 12, Second Semester			
English‡	5	0	5
Introduction to COBOL Programming	3	2	5
Punched Card Data Processing II**	3	2	5
Computer Operations**	3	2	5
Keypunch and Data Entry**	2	3	5
Total	16	9	25

*Suggested electives include Business Law, Shorthand, Psychology, Speech, Language, or any other courses which meet the student's specific program objectives.

**Course description and outline provided in previous section.

†Business Math is recommended.

‡Business English is recommended.

Appendix C

A Selected List of Film Distributors

American Telephone and Telegraph
(Write or phone local office.)

Bell Telephone Company
(Write or phone local office.)

California Computer Products
2411 W. La Palma Avenue
Anaheim, California 92801

City University of New York
Audio-Visual Center
School of Business & Public Administration
17 Lexington Avenue
New York, New York 12452

Data Processing Management Association
505 Busse Highway
Park Ridge, Illinois 60668

Detroit Public Schools
5057 Woodward Avenue
Detroit, Michigan 48202

DeVry Technical Institute
4141 Delmont Avenue
Chicago, Illinois 60641

Educational Development Center
39 Chapel Street
Newton, Massachusetts 02158

Encyclopedia Britannica, Inc.
Educational Division
425 North Michigan Avenue
Chicago, Illinois 60611

Film Associates of California
1159 Santa Monica Boulevard
Los Angeles, California 90025

Ford Motor Company
Film Library
The American Road
Dearborn, Michigan 48121

General Dynamics
Electronic Division
San Diego, California 92101

General Electric Company
FPD Technical Information Center
Cincinnati, Ohio 45215

General Electric Educational Films
60 Washington Avenue
Schenectady, New York 12305

General Motors Corporation
Film Library
Warren, Michigan 48089

Harvard University
Cambridge, Massachusetts 02138

John Wiley & Sons, Inc.
Educational Services
605 Third Avenue
New York, New York 10036

Ideas Information
P. O. Box 446
Melbourne, Florida 32901

Massachusetts Institute of Technology
Electronic Systems Laboratory
Cambridge, Massachusetts 02139

Modern Talking Picture Service, Inc.
2323 New Hyde Park Road
New Hyde Park, New York 11040

National Cash Register Company
Audio-Visual Section
Dayton, Ohio 45409

National Film Board of Canada
680 Fifth Avenue
New York, New York 10036

National Science Film Library
1762 Carling
Ottawa 13, Ontario, Canada

NET Film Service
Indiana University
Audio-Visual Center
Bloomington, Indiana 47401

Orange Coast Junior College
Costa Mesa, California 92626

Oregon State University
Division of Continuing Education
A. V. Section, Coliseum 131
Corvallis, Oregon 97331

Pennsylvania State University
Audio-Visual Services
University Park, Pennsylvania 16802

Purdue University
Audio-Visual Center
Lafayette, Indiana 47907

Radio Corporation of America
Film Library
Camden, New Jersey 08101

Rand Corporation
1700 Main Street
Santa Monica, California 90401

Recognition Equipment Incorporated
815 Connecticut Avenue
Washington, D.C. 20015

Reelife Productions
1809 Via Visalia
Palos Verdes Estates, California 90275

Systems Development Corporation
2500 Colorado Avenue
Santa Monica, California 90404

U. S. Navy
(Write or phone the nearest U.S. Navy Base.)

Union Carbide Corporation
270 Park Avenue
New York, New York 10017

UNIVAC Film Library
UNIVAC Division
Sperry Rand Corporation
P. O. Box 8100
Philadelphia, Pennsylvania 19117

University of California
Media Center
Film Distribution
Berkeley, California 94720

University of Georgia
Film Library
Center for Continuing Education
Athens, Georgia 30601

University of Illinois
704 South Sixth Street
Champaign, Illinois 61820

University of Iowa
Audiovisual Center
Division of Extension and University Services
Iowa City, Iowa 52240

University of Michigan
Audio-Visual Education Center
416 Fourth Street
Ann Arbor, Michigan 48103

Appendix D

Supplementary References For Use In Secondary School Instruction

Introductory Texts for High School Students

Albrecht, R. L., E. Lindberg and W. Mara. *Computer Methods in Mathematics.* Reading, Massachusetts: Addison-Wesley Publishing Co., 1969.

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Programming Language Textbooks

Basic

Albrecht, R. L. *Teach Yourself BASIC.* (Volume I and II), Menlo Park, California: Tecnica Education Corp., 1970.

Coan, J. S. *Basic BASIC: An Introduction to Computer Programming in BASIC Language.* New York: Hayden Book Co., 1970.

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FORTRAN

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COBOL

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